Can Enhanced Traceability Generate Extra Value-Added for Cattle at Auction?

Dr. Jared G. Carlberg, Associate Professor
Department of Agribusiness & Agricultural Economics
University of Manitoba
jared_carlberg@umanitoba.ca

Dr. Robert J. Hogan, Associate Professor & Extension Economist
Texas A&M University
rhogan@ag.tamu.edu

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Introduction

Federal and provincial governments in Canada are making large-scale investments in traceability systems. The May, 2003 discovery of Bovine Spongiform Encephalopathy (BSE) in a downer cow in northern Alberta and closure of international markets (most prominently the US) to Canadian cattle and beef caused billions of dollars in economic losses to the industry. Implementation of traceability systems is considered by many to be an important step in ensuring that the effects of future animal disease-related events are not as disruptive.

It can be difficult to justify the costs of these systems based on their "what-if" possibilities alone. Empirical studies of the benefits generated by these systems focus on reducing the costs associated with beef and cattle embargoes by shortening their duration. However, some research has demonstrated that the costs of these systems is not justified by those benefits alone (Jones 2010). Nevertheless, there are additional economic benefits associated with increased traceability that may be sufficient to tip the balance in favour of enhanced traceability systems. One of these benefits is the increased ability to trace value-added cattle attributes more precisely through the production and marketing system. In order to accomplish this, it is necessary to be able to accurately measure the value of those attributes.

This research reports the results of analysis of data collected between October 2011 and October 2012 on cattle sales at two auctions in Stavely, Alberta and Stettler, Alberta. Data were collected on more than 79,000 head of cattle between the two locations during the period of study; approximately 24,000 at Stavely, south of Calgary, and more than 55,000 at Stettler, east of Red Deer. An important goal of the research was to determine the factors that affect auction prices, with special attention paid to "value added" characteristics such as age-verification, being home-raised, hormone-free status, and being part of a preconditioning program.

The principal objective of the research reported in this paper is to measure the value of traceable cattle attributes at auction. Much of the information that affects cattle auction prices is not currently collected, nor is it passed effectively among stages in the supply chain. Enhanced traceability systems will allow this information to be exchanged in a more efficient and cost-effective way. Producers, cattle feeders, and auction marts may be more willing to increase their own investments in traceability if it can be demonstrated that the there are premiums associated with traceable attributes. A secondary objective of the research is to add to the literature on cattle auction market price discovery using a large and recent dataset.

The remainder of this paper is divided into four sections. The first of these describes the data used in the analysis. After that, the empirical model and methodology employed are described. The next-to-last section of the paper presents results of the econometric models used in the analysis, and a final section summarizes and draws conclusions.

Data

Data for this research were collected at two cattle auction markets (discussed in more detail below) in the province of Alberta from October 2011 through October 2012. Crosier (2012a) provides an excellent overview of the data collection processes implemented at the two auction

markets. More than 79,000 head (approximately 24,000 at Stavely and 55,000 at Stettler) in over 5,800 (incoming) lots (which were then usually broken down into smaller sale lots) were radio frequency identification (RFID) scanned during the data collection period.

The auction market at Stavely is situated in the heart of Alberta's Rocky Mountain foothills in traditional ranching country. A considerable proportion of the cattle going through this location are sourced from large ranches that run cattle along the foothills. Cattle sold at this location are in many cases sort groups from large herds via video or through some other alternative selling methodology. As an example, a large ranch in the area may choose to sell a few hundred calves in groups with uniform characteristics through an internet or video sale. Animals that are outside of the desired weight range, or other cattle sorted off for one reason or another, may end up being auctioned at the Stavely market. The auction mart at Stavely is regularly attended by order buyers from two packing plants for cull cows and bulls, whose plants are within easy proximity of the market. This market is also accessible to Picture Butte, which has the region`s largest inventory of cattle on feed.

The auction mart at Stettler is located outside the city of Red Deer, Alberta, in a mixed farming area where cattle graze on open pastures or grain fields. Cattle sellers at Stettler come from mostly mixed-farm operations. Order buyers from the two major regional packing plants (Lakeside at Brooks, Alberta and Cargill at High River, Alberta) regularly attend auctions at Stettler to purchase cull cows and bulls. Distance to Brooks and to High River are further than for Stavely, yet still fully accessible. The large Picture Butte, Alberta area cattle feeding region is about an additional 250 kilometers further removed from Stavely.

The data collected at the two locations can be broken down into sub-sets for the purposes of analysis. For example, "calf" sales take place at particular times on specific days of the week, allowing for analysis of animals sold at those sales to see whether different factors affect prices than at "regular" sales, which are the normal sales taking place at auction markets. Stavely had over 1,300 lots of cattle sold at calf sales and nearly 5,000 sold at regular sales during the period of study, while Stettler had over 1,800 calf sale lots and more than 15,000 regular sale lots during the same period. The sale lots could be further broken down into "show alley" sales, which featured cattle sold based on a predetermined shrink with their weight having been determined the day prior to the sale, or "standard alley" sales, in which a lot's animals are weighed on sale day and sold on that basis. Stavely saw just under 1,000 lots of show alley cattle sold and nearly 5,300 lots of standard alley sales, while Stettler had over 2,100 show alley lots and nearly 15,000 standard alley lots.

Sale lots were also broken down by age into calf, mature and yearling sales for analysis. For Stavely, approximately 2,200 lots were identified as calf sales (which would include but not be limited to lots sold at the calf sales described above), while there were about 8,300 such lots sold at Stettler. For sales of what were described as mature cattle, Stavely processed about 3,300 lots, while Stettler handled around 7,000. Lastly, there were sales of around 1,000 lots of yearlings during the study period at Stavely, while the same period saw around twice as many lots of yearlings sold at Stettler.

The final set of major data categories for analysis were the various sale lot weight ranges at the two auction markets. Lots were categorized by average weight of cattle in the lot, then assigned into groups for 300-399 lbs, 400-499 lbs, etc., all the way up to 900-999 lbs, then 1000 lbs and above. In general (but not without exception), there were fewer lots of very low weight ranges, with higher numbers of slaughter-weight lots. For example, Stavely had only about 240 lots where the average weight was 300-400 pounds, but more than 3,300 lots where the average weight exceeded 1,000 lbs. Similarly, there were 575 lots of cattle averaging between 300 and 400 lbs sold at Stettler, but nearly 7,400 lots of 1000+ pound average weight animals.

Model & Methodology

Cattle prices have been the subject of a considerable volume of research by agricultural economists in the United States. For example, Bulut, Lawrence and Martin (2006) constructed a model for determining the value of third-party certification claims at feeder auctions in Iowa. Given that a number of the goals of this research are similar (establishing the value of cattle attributes such as age-verification, participating in a preconditioning program, being designated as home-raised, being hormone-free), Bulut, Lawrence and Martin (2006) approach was selected as the empirical foundation for this research. Of course, given that a number of variables expected to impact cattle prices in Alberta auction markets were not included in their model, the one constructed for this research has been tailored to the available data.

The econometric model used for this research can be written as follows:

(1) $Price_t = \beta_0 + \beta_1 Week_t + \beta_2 Futures_t + \beta_3 AV_t + \beta_4 Orig_t + \beta_5 HF_t + \beta_6 Prog_t + \beta_7 Horns_t + \beta_8 Head_t + \beta_9 Head_t^2 + \beta_{10} Cow_t + \beta_{11} Heifer_t + \beta_{12} Steer_t + \beta_{13} Stag_t + \beta_{14} Brit_t + \beta_{15} Black_t + \beta_{16} Avg\_Wt_t + \beta_{17} Avg\_Wt_t^2 + \beta_{18} Feb_t + \beta_{19} March_t + \beta_{20} April_t + \beta_{21} May_t + \beta_{22} June_t + \beta_{23} July_t + \beta_{24} Aug_t + \beta_{25} Sept_t + \beta_{26} Oct_t + \beta_{27} Nov_t + \beta_{28} Dec_t + e_t$

Where the variables are defined as:

$Price_t$ = the selling price per cwt. for the t^{th} lot

$Week_t$ = the sales week of the lot (starting at week 1 in October, 2011). This variable is included to capture the passage of time and any underlying effects that may be associated with that. There is no strong prior expectation regarding the sign of this variable.

$Futures_t$ = the price of the nearby Chicago Mercantile Exchange fat cattle futures contract for the day of the sale of the lot. The futures market can serve as a guide to cattle buyers and sellers regarding expectations about prices as well as underlying supply and demand conditions. It is generally expected that there will be a direct rather than inverse relationship between futures prices and auction mart sale price.

AV_t = age-verification variable; recorded as "Yes" if the auctioneer announced at the time of the sale that the lot was age-verified. If there is a value in the market to age-verification, this variable will have a positive effect upon selling price.

$Orig_t$ = recorded as "Yes" if the auctioneer announced at the time of the sale that the lot was home-raised. If there is a value in the market to being home-raised, this variable will have a positive effect upon selling price.

HF_t = recorded as "Yes" if the auctioneer announced at the time of the sale that the lot was raised with no added hormones. If there is a value in the market to being hormone-free, this variable will have a positive effect upon selling price.

$Prog_t$ = recorded as "Yes" if the lot was part of a preconditioning (weaning and vaccination) program. If there is a value in the market to being preconditioned, this variable will have a positive effect upon selling price.

$Horns_t$ = 1 if the lot has horns. If animals with horns are less valuable in the market, this variable will have a negative effect upon selling price.

$Head_t$ = number of head in the lot. If there is a value in the market for larger lot sizes, this variable will have a positive effect upon selling price.

$CowDum_t$, **$HeiferDum_t$**, **$SteerDum_t$**, **$StagDum_t$** = indicator variables for cows, heifers, steers, and staggy animals, respectively. The base category was bulls. If, for example, cows are less valuable than bulls in the market, the indicator variable for cows will have a negative sign.

$Brit_t$ = 1 if the lot contains a British breed. If British breeds are more valuable in the market, this variable will have a positive effect upon selling price.

$Black_t$ = 1 if the lot contains animals with a black hide. If black animals are more valuable in the market, this variable will have a positive effect upon selling price.

Avg_Wt_t = the average weight of the lot. If heavier animals are less valuable in the market, this variable will have a negative effect upon selling price.

Feb_t , $March_t$, $April_t$, May_t, $June_t$, $July_t$, Aug_t, $Sept_t$, Oct_t, Nov_t, Dec_t = indicator variables for each month. This variable will capture the effect on price (if any) for sales in (for example) February compared to sales in January, the base month.

A Chow test was used to test the null hypothesis that data from the two markets were generated by the same underlying process and could thus be pooled vs. the alternative that the data result from separate processes. The null was rejected (p- value < 0.0001) and so it was necessary to estimate the model described above for each market separately. This is principally due to the different types of buyers and sellers found at the two markets—Stavely is regarded as "ranching territory", and is more likely to be frequented by those whose principle business activity focuses heavily on cattle. On the other hand, Stettler is in mixed-farming country, where agricultural producers do not have to focus as heavily on cattle production. One industry observer summarized the two markets' patrons as being "cowboy hats [at Stavely] vs. John Deere caps [at Stettler]."

Augmented Dickey-Fuller tests were used to test the series for stationarity and indicated that the data were stationary, as expected, and did not need to be differenced. Tests on the residuals rejected normality, but histograms of the residuals revealed bell shaped distributions that deviated from normal shape in the tails and peakedness. A Q-Q plot revealed the same information, so the residuals will be assumed to be normal-like. Auctocorrelation function (ACF) and partial autocorrelation function (PACF) were generated to examine the series for autocorrelation. The PACF confirmed suspicions that autocorrelation exists for both markets.

Joint conditional means and joint conditional variance tests (McGuirk, Driscoll and Alwang 1993) were performed on model residuals for both markets. Results of those and additional specification tests suggested the presence of autocorrelation and dynamic heteroskedasticity. The AUTOREG procedure in SAS version 9.3 was used to estimate the models for both markets using an AR(5)-GARCH(1,1) approach. This removed the autocorrelation and heteroskedasticity from the models, resulting in estimates that are consistent and efficient.

Results

Tables 1a and 1b show base model results for Stavely and Stettler, respectively, which include all data collected at each of the locations during the period of study. The Stavely results shown in Table 1a reflect all of the 23,996 head marketed there from October 2011 to October 2012. On average, cattle prices at this location had significant premiums associated with being announced by the auctioneer as age verified ($3.94/cwt), being announced as home raised ($5.55/cwt), and being announced as being put through a preconditioning program ($7.97/cwt). There was no premium resulting from being announced as hormone free at Stavely. As expected, steers and heifers brought significant premiums when compared to bulls, and there was a heavy discount associated with staggy animals and cattle with horns.

Table 1a. Base model results, Stavely auction market

Variable	Effect on Price	Amount	Description
Futures Price	None	—	Futures price did not affect price
Age Verified	Positive	$3.93/cwt	Age verification increased price $3.93/cwt
Home Raised	Positive	$5.55/cwt	Being home raised increased price $5.55/cwt
Hormone Free	None	—	Hormone free status did not affect price
Preconditioned	Positive	$7.97/cwt	Being in a preconditioning program increased price $7.97/cwt
Horns	Negative	$15.26/cwt	Presence of horns decreased price $15.26/cwt
Lot Size	Positive	$0.75/cwt	Increasing lot size by one head increased price $0.75/cwt
Cow	Negative	$11.69/cwt	Cows were worth $11.69/cwt less than bulls
Heifer	Positive	$4.13/cwt	Heifers were worth $4.13/cwt more than bulls
Steer	Positive	$16.64/cwt	Steers were worth $16.64/cwt more than bulls
Stag	Negative	$30.70/cwt	Stags were worth $30.70/cwt less than bulls
British Breeds	Positive	$3.62/cwt	British breeds brought a $3.62/cwt premium
Black Animals	None	—	There was no premium for black animals
Average Weight	Negative	$0.11/cwt	Each 100 pound increase in average weight brought a $0.11/cwt discount

There was a premium of $3.62/cwt associated with British breeds at Stavely, but no extra premium for black animals. Larger lot sizes did receive a small premium on average ($0.75/cwt for every additional head. Lastly, as the average weight of animals in a lot increased by a hundredweight, there was a decline in price at auction of eleven cents per hundredweight. This is in accordance with the price slides that are regularly encountered in the cattle industry.

The coefficients shown in Table 1b are representative of the 55,266 head marketed at Stettler between October 2011 and October 2012. Results suggest that movements in cattle futures do affect prices at that market, with a $1/cwt. increase in futures causing a $0.34/cwt. price increase, all other things being equal. There was a price premium of $3.23 associated with cattle being announced as age-verified, but across all cattle there were no premiums associated with being announced as home-raised or hormone-free. There was, however, a $5.88/cwt. premium resulting from being announced as preconditioned.

The presence of horns caused a $2.27/cwt. discount in cattle on average at Stettler. There were also discounts associated with cows ($11.92/cwt. compared to bulls), British breeds ($0.78/cwt.), and increasing average weight in a lot ($0.13/cwt. per additional 100 pounds). Both heifers and steers received premiums compared to bulls ($1.56/cwt. and $15.57/cwt., respectively), and there was also a premium associated with increasing lot size ($0.39/cwt. for every additional head). Somewhat surprisingly, there was no premium (on average) associated with a black hide; nor was there a significant discount associated with staggy animals (compared to bulls). Of course, this does not mean that such premiums/discounts would not exist with respect to individual animals or individual lots.

Table 1b. Base model results, Stettler auction market

Variable	Effect on Price	Amount	Description
Futures Price	Positive	$0.34/cwt	A $1.00/cwt increase in the futures price increased prices $0.34/cwt
Age Verified	Positive	$3.23/cwt	Age verification increased price $3.23/cwt
Home Raised	None	—	Being home raised did not affect price
Hormone Free	None	—	Hormone free status did not affect price
Preconditioned	Positive	$5.88/cwt	Being in a preconditioning program increased price $5.88/cwt
Horns	Negative	$2.27/cwt	Presence of horns decreased price $2.27/cwt
Lot Size	Positive	$0.39/cwt	Increasing lot size by one head increased price $0.39/cwt
Cow	Negative	$11.92/cwt	Cows were worth $11.92/cwt less than bulls
Heifer	Positive	$1.56/cwt	Heifers were worth $1.56/cwt more than bulls
Steer	Positive	$15.57/cwt	Steers were worth $15.57/cwt more than bulls
Stag	None	—	Staggy appearance did not affect price
British Breeds	Negative	$0.78/cwt	British breeds brought a $0.78/cwt discount
Black Animals	Negative	$0.75/cwt	Black animals brought a $0.75/cwt discount
Average Weight	Negative	$0.13/cwt	Each 100 pound increase in average weight brought a $0.13/cwt discount

As noted above, further analysis of the data grouped lots of cattle by sale type (calf and regular), sale sub-type (show alley and standard alley), animal age (calf, mature and yearling), and weight ranges (in one-hundred pound increments, starting at 300-400 pound calves, all the way up to the final grouping being 1000 pounds and heavier). Space considerations prevented the inclusion of results for all of these groupings in this paper; nevertheless, results for each of the models for the two auction markets are summarized in Tables 2a and 2b, below.

Table 2a summarizes the price effects discovered across the sixteen models estimated using data from the Stavely auction market. With respect to the value-added attributes, age verification is found to generate premiums in only three of the models, but, perhaps importantly, the base model is one of them. Preconditioning is found to result in premiums in just under half the models, again including the base model. Being announced as hormone free resulted in premiums in only a few of the models, not including the base model. Being home raised resulted in premiums in the base model as well as a few other models.

Animals with horns were discounted in virtually all of the Stavely models; there were also consistent discounts associated with increasing average weight. British breeds consistently received premiums in sales held at Stavely, although premiums for black animals seemed to be sporadic at best. Steers generally received premiums compared to bulls while cows were discounted; by comparison heifers usually (but not always) received premiums. Lastly, increasing lot sizes were typically accompanied by higher prices, all other things being equal.

Findings from the sixteen models run for the more than 55,000 head of cattle sold at Stettler between October 2011 and October 2012 are provided in Table 2b. As the table shows, age verification generally exerted a positive influence upon price at Stettler, including in the base model that considered all head sold over the study period. There were also consistent premiums for preconditioned cattle, as confirmed by the results of more than half the models, including the base model. There was, however, no consistent value added resulting from being home raised or from being announced as hormone free.

Steers consistently earned premiums compared to bulls in the Stettler models, while cows were discounted relative to bulls in all but one of the sixteen models. Heifers earned premiums compared to bulls in ten of the models (including the base model) but discounts in the remaining six. A staggy appearance did not appear to affect price. British breeds only brought premiums in one of the Stettler models, which stands in stark contrast to Stavely, where British breeds tended to be more highly valued than other breeds. Black animals sometimes received premiums and sometimes received discounts; other times there was no price effect associated with black hides. As at Stavely, there was a pervasive positive influence at Stettler for increasing lot size, and a negative one for increasing average weight in a lot.

Table 2a. Summary of variables' effects on price, Stavely

Variable	Base Model	Calf Sales	Reg. Sales	Show Alley	Std. Alley	Age: Calf	Age: Mat.	Age: Yrlng.	Wgt. 3-4	Wgt. 4-5	Wgt. 5-6	Wgt. 6-7	Wgt. 7-8	Wgt. 8-9	Wgt. 9-10	Wgt. 10+
Futures	n/a	+	n/a	n/a	n/a	+	+	+	+	+	+	+	n/a	n/a	n/a	+
Age Verified	+	n/a	n/a	+	n/a	n/a	+	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Home Raised	+	n/a	+	+	+	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hormone Free	_	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	+	+	+	n/a	n/a	n/a
Precond.	+	n/a	+	-	+	n/a	n/a	+	+	n/a	n/a	-	+	n/a	n/a	+
Horns	-	-	-	-	-	-	-	-	-	-	-	-	-	-	n/a	-
Lot Size	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cow	-	-	-	n/a	-	n/a	-	n/a	n/a	n/a	n/a	-	-	-	-	-
Heifer	+	-	+	+	+	-	+	+	-	-	n/a	n/a	-	+	n/a	+
Steer	+	+	+	+	+	+	n/a	+	n/a	n/a	+	+	n/a	+	+	+
Staggy	-	n/a	-	n/a	-	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	+
British	+	+	+	+	+	+	+	+	+	+	+	-	+	+	n/a	+
Black	n/a	n/a	n/a	+	n/a	n/a	n/a	n/a	n/a	n/a	+	+	-	n/a	n/a	n/a
Avg. Wgt.	-	-	-	-	-	-	n/a	n/a	n/a	n/a	n/a	-	n/a	n/a	n/a	-

Table 2b. Summary of variables' effects on price, Stettler

Variable	Base Model	Calf Sales	Reg. Sales	Show Alley	Std. Alley	Age: Calf	Age: Mat.	Age: Yrlng.	Wgt 3-4	Wgt 4-5	Wgt 5-6	Wgt 6-7	Wgt 7-8	Wgt 8-9	Wgt 9-10	Wgt 10+
Futures	+	-	+	n/a	+	-	+	n/a	-	n/a	-	-	n/a	-	n/a	+
Age Verified	+	n/a	+	+	+	+	n/a	n/a	-	n/a	+	+	n/a	-	n/a	+
Home Raised	n/a	n/a	n/a	-	n/a	n/a	n/a	n/a	n/a	n/a	n/a	+	n/a	n/a	n/a	n/a
Hormone Free	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-	n/a	n/a	+	n/a	+
Precond.	+	n/a	+	+	+	+	n/a	+	n/a	n/a	n/a	n/a	n/a	+	+	+
Horns	-	-	-	n/a	-	-	n/a	-	-	-	n/a	-	-	-	-	-
Lot Size	+	+	+	n/a	+	+	+	+	+	+	+	+	+	+	+	+
Cow	-	n/a	-	n/a	-	n/a	-	n/a	n/a	n/a	+	-	-	-	-	-
Heifer	+	-	+	-	+	-	+	+	-	-	-	+	+	+	+	+
Steer	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Staggy	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	+
British	-	n/a	-	n/a	-	n/a	-	n/a	n/a	n/a	n/a	+	n/a	-	n/a	-
Black	-	-	-	+	n/a	-	+	-	n/a	n/a	+	+	n/a	+	n/a	n/a
Avg. Wgt.	-	-	-	-	-	-	+	-	+	n/a	-	-	n/a	n/a	n/a	n/a

Summary & Conclusions

The objectives of the research reported in this paper were to measure the value of cattle attributes at auction and, by doing so, to augment the existing literature on cattle auction market price discovery. To accomplish these objectives, auction market data were collected at Stavely, Alberta and Stettler, Alberta during the one-year period from October 2011 to October 2012. Overall, more than 79,000 combined head in over 5,800 lots were sold at the two lots; about 24,000 at Stavely and 55,000 at Stettler. Specification testing of initial econometric models suggested data from the two markets could not be pooled; subsequent modeling considered the two markets separately. The estimation procedure employed corrected for the autocorrelation and heteroskedasticity that was initially present in the models.

It was discovered that the "value added" attributes of being age verified, home raised, hormone free and preconditioned affected transactions prices at the auction markets to varying extents. Age verification had a positive impact upon cattle prices in the base model for cattle at both Stavely and Stettler, as did enrolment in a preconditioning program. Being home-raised had a positive effect (in the base model) on price at the Stavely market but no effect at Stettler, while being announced as hormone free had a negative impact on prices in the base model for Stavely and no effect on price at Stettler. In the more disaggregated analyses, where models were estimated for specific sale types, cattle ages, alley types weight ranges, there was considerable variation in results.

Overall, it may be fair to say that some premiums exist for value-added attributes in the cattle markets from which the data for this research were obtained. However, cattle sellers must take pains to ensure they understand what buyers are seeking in the market and target their animals to meet those demands. Different buyers are often looking for different products on different days. In order for the additional premiums generated by value-added attributes to help justify increased public and private expenditures on traceability initiatives, it is important to be able to both measure and understand them. Results of this research suggest that there are premiums available, although it can be difficult to identify opportunities to exploit them. It is expected that future work will more fully explore the potential for these value-added attributes to contribute to the cost effectiveness of traceability systems.

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