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INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Int. J. Food System Dynamics 11 (3), 2020, 221-240

DOI: http://dx.doi.org/10.18461/ijfsd.v11i3.51

Differences in Production Costs Across Compliance Scenarios for Canadian Cow-Calf Producers Accessing the EU Market

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Received September 2019, accepted June 2020, available online July 2020

ABSTRACT

Using the 2016 Canada EU Trade Agreement as context, we develop a systems dynamics model to assess changes in the cost of production from a production system oriented toward the North American market where growth enhancing products are allowed, to a European market where these production practices are banned. We outline four different compliance scenarios and use data from western Canadian institutions to estimate how the cost of production for cow-calf producers changes in the different compliance scenarios. We find that compliance costs ranged from $2.13 per head for those firms who already had forgone growth enhancing products and were maintaining detailed records to $34.78 per head for farms who were least compliant with EU standards.

Keywords: *Beef production; trade agreements; compliance; growth enhancing products; systems dynamics*

1 Introduction

The Canada-European Union Comprehensive Economic and Trade Agreement (CETA), was signed on October 30th, 2016. This new agreement eliminates 98 percent of tariffs for Canadian goods entering the EU, with further reductions expected over several years (Government of Canada, 2016). For Canadian beef, duty-free market access totaling 64,950 tonnes (carcass weight equivalent) will come into effect over five years. This trade opportunity could represent a $600 million dollar value to Canadian beef producers (Canadian Cattlemen's Association, 2014). However, beef exported to the EU must be produced without growth enhancing products (GEP's). This means that a minimum of 157,000 certified growth enhancing product (GEP)-free cattle must be produced to fill the 64,950 tonne quota[1] (Duckworth, 2017a).

For Canadian beef producers, the CETA presents an opportunity to market their production to a new and potentially valuable market – provided they can produce and export their product to EU standards. Recent work by Witte (2018) found that within a sample of Canadian beef producers, a majority found trade agreements to present an opportunity, while younger respondents suggested that the industry as whole could be more responsive to market changes. Responsiveness could include greater dissemination of the different standards needed to access new markets that have been opened through trade negotiations. As there is a large degree of heterogeneity amongst cow-calf producers and their practices, some producers are already in a relatively 'more compliant' position with respect to EU regulations than others (Western Beef Development Centre, 2015; Manglai, 2016). Therefore, a singular approach to evaluating the farm level economic impacts of entering the EU market channel does not adequately reflect the level of variation amongst producers.

The purpose of this paper is to estimate the cost of producing beef calves under an EU certified production regime. As this question looks at biological and economic systems, a systems dynamics model provides a tool to understand how production practices and biological responses affect a price premium needed by producers to become compliant. Systems dynamics models have been used in the past for research questions such as grazing resource allocation (Woodworth, 1973; D'Aquino, 1974), risk in production (Whitson, 1975) and sustainable production and distribution (Dondè et al., 2016). One of the most commonly cited models is Texas A&M University's (TAMU) Cattle Production Systems Model (Sanders, 1977; Sanders and Cartwright, 1979a; Sanders and Cartwright 1979b), which simulates individual cattle production performance in response to a variety of pre-determined factors. Some systems models have been developed to address a specific research question, rather than applying one of the generalized models previously described. For example, Turner et al. (2013) developed a STELLA model using actual production data from a 12,000-cow ranch in Nebraska for the purpose of simulating marketing decisions regarding cow sales. Rich, Perry and Kaitibie (2009) used a systems modelling methodology to develop a cost-benefit model to determine the economic feasibility of implementing a sanitary certification system for Ethiopian beef exports.

While signing the CETA opens the EU market to Canadian beef producers who choose to produce according to EU standards, the feasibility of this trade opportunity vis-à-vis other market opportunities still needs evaluation. Starting with the first segment of the beef supply chain, cow-calf production, this paper utilizes a systems dynamics approach to attempt to quantify the economic impact that meeting EU beef production regulations would have on Canadian cow-calf farms. As certification for the EU market is expected to increase production costs both directly and indirectly, the results of this research will provide an estimate of the price premium cow-calf producers must be offered in order to offset the costs of compliance with EU market standards. Further, taking advantage of the increased allocation negotiated as part of CETA requires the coordination of the entire beef supply chain, therefore this paper offers some insight for downstream partners on the required premiums they must offer to procure certified cattle.

The results indicate that a range production costs exist, which vary in accordance with existing production practices. For producers that already choose to forego GEP usage and maintain a management identification system, the addition to their cost of production (COP) is estimated to be only $2.13 per calf. Conversely, producers that use GEP's and have not implemented identification protocols to a large degree face a much larger impact of $34.78 per calf. Therefore, it can be seen that the cost of compliance to EU certified production may vary greatly across the cow-calf stage of the supply chain.

[1] 64 950 tonne CWE, assuming 63% carcass yield from live weight (Holland, Loveday and Ferguson, 2014).
64 950 tonne/0.63 = 103 095 tonne / 658 kg live weight (ACFA, n.d.) = 156 680 live cattle

In the following section, EU market standards are examined in greater depth, along with the adjustments that various subsets of cow-calf producers would need to undertake to achieve compliance. Key production practices and administrative tasks are identified which are necessary to achieve compliance, along with cost estimates of each. Next, the COP is estimated for each base case production scenario and compared to that of an EU compliant production scenario. Finally, we analyze the break-even price difference between the base production scenarios and the EU compliant scenario. The purpose is to estimate a minimum premium which each subset of producers would need to offset the costs of compliance with EU standards and be indifferent between production systems from a profit perspective

2 Background

Growth Enhancing Products (GEPs) are a management tool available to beef producers since the 1950s. There are six hormone substances approved for use in Canada including estrogen, testosterone and progesterone, which are naturally occurring, and zeranol, melengestrol acetate and trenbolone acetate, which are synthetic (Canadian Animal Health Institute, 2003).[2] Most of these substances are administered as a small pellet implanted under the skin of the animal's ear (Johnson and Beckett, 2014). The purpose of implanting is to improve the rate of average daily gain, increase feed intake and improve feeding efficiency, while also increasing lean muscle deposition (Johnson and Beckett, 2014; Reinhardt, 2007).

At the cow-calf production stage, zeranol, progesterone and estrogen GEP's may be administered to suckling calves. In western Canada, 24 percent of cow-calf producers reported implanting their calves either prior to, or at weaning time (Western Beef Development Centre, 2015). Low adoption rates have also been observed among US cow-calf producers, where Deblitz and Dhuyvetter (2013) show that 10 percent of all producers reported implanting their calves, while the rate of adoption increased with herd size. Similar trends in adoption of hormone implants were observed by Ward et al. (2008) in Oklahoma cow-calf firms. Low adoption rates for growth enhancing technology in the cow-calf sector can largely be attributed to the diversity between farms, which causes the pace of adoption to be slower than that of the more homogenous feedlot industry (Galyean, Ponce and Schutz, 2011).

As these substances are prohibited in the EU, beef destined for this market must meet certain criteria to assure that it is GEP-free. To provide this assurance, the Canadian Food Inspection Agency (CFIA) administrates the 'Canadian Program for Certifying Freedom from Growth Enhancing Products for the Export of Beef to the European Union', which will be referred to as the 'program' hereafter. There are 10 key components of the program which producers must comply with for CFIA to grant them an export certificate[3] to the EU (Table 1). CFIA approved veterinarians oversee adherence to these program components and conduct on-site assessments at least once per year. Additionally, once the animals reach the EU approved processing facility, they will also be subjected to physical checks for implants and have samples taken to test for hormonal residue (Canadian Food Inspection Agency, 2016).

Given that 2015 Canadian bovine meat exports to the EU totalled only 326 tonnes, over half of which was bison, it is clear that the participation of more beef producers will be needed if the CETA tariff-free beef quota is to be utilized (Global Trade Atlas, 2017). However, increased labour burden and reduced productivity makes the cost of production for the EU channel greater than conventional ones. Producers considering the EU market channel will be faced with a decision to balance the additional costs of enrolling calves in this program with the benefits they expect to receive from having access to this alternative marketing channel.

[2] Growth hormones supplement substances naturally produced by the animal. Hormones are present in all beef, as well as a variety of other foods, regardless of whether or not the animal it was derived from was treated (Canadian Animal Health Institute, 2003).

[3] Granting of an export certificate by CFIA means that beef derived from the enrolled animal is eligible to be imported by the EU.

Table 1.
Producer Guidelines for Compliance with CFIA Export Certificate

Identification
Animals to be exported must be identified under the Canadian livestock identification and traceability program. Therefore, they need to carry an approved identification tag that has a unique number. If the farm is mixed-status, meaning some animals may be implanted and sold into the other channels, the animals intended for EU export must have an alternate visual identifier in addition to the approved traceability program tag. These animals must easily be identified in a walk-through and marked prior to any handling where they may be implanted.
Prior to leaving the farm of origin, the animal must be identified with an approved tag. If this tag is lost or revoked throughout the growing period, it can be replaced by a designated person at the farm or feedlot and documentation recording replaced tags must be kept.
Records
All animals in the program must originate at a registered farm or feedlot. Birth farms must be registered before the animal is transferred to another registered operation. Before the animal arrives, the feedlot or auction mart must also be registered.
Inventory of animals in the program must be accurate and kept up to date.
Records identifying the ingredients in any mixed feeds or feed supplements, as well as their source, that are given to enrolled animals must be maintained.
The required records must be made available to CFIA or EU Officials upon demand and maintained for at least three years for birth farms, and two years for feedlots and auction markets from the date the animals were received.
Movement and traceability
Animals in the program may only be transferred to farms or auction markets that are also registered to maintain their eligibility in the program.
Traceability of the animals must be maintained throughout their life, from birth through the slaughter process. Transfer documentation has to be CFIA accepted and must be provided upon arrival at the slaughter facility.
Animals must never be administered any growth enhancing products throughout their entire life.
Farms in the program which use these products, or have them on the premises, must record their purchases and the use or disposal of them.

3 Model Development

The BE for western Canadian cow-calf operations will be simulated using a deterministic systems modelling approach. Systems modelling provides a method by which production processes can be mimicked, then variables can be manipulated to simulate various outcomes (Ruth and Hannon, 1997; Mayer, 2002). An advantage of using a systems dynamics model is the ability to conceptually lay out the interactions of the variables, in addition to running simulations. This is because each variable must either be defined by a parameter if it is a boundary variable, meaning the system does not extend beyond it, or an equation if the variable interacts with others.

First, the break-even (BE) variable and its components are mapped out. Break-even is directly determined by total production costs and total output. These variables alone are not enough to adequately simulate BE since there are several other factors which influence costs and productivity. Mapped in Figure 1 are the directions of causality for variables indirectly influence BE through their relationship with the direct factors that comprise the BE metric.

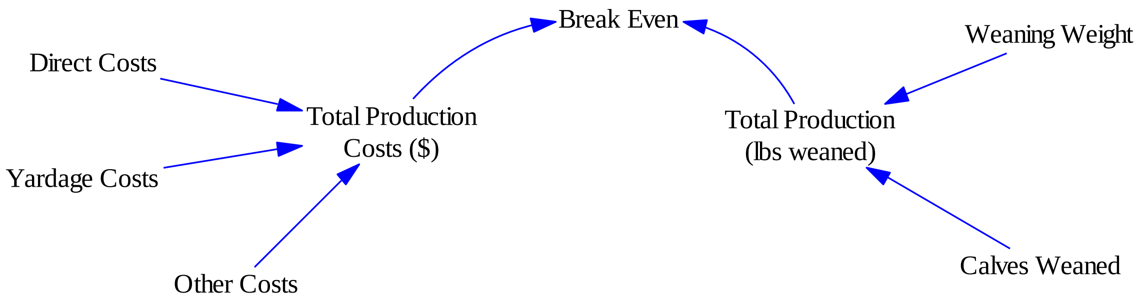

Figure 1. Break-Even Drivers

There is still another level of variables to add to Figure 1, as several of these cost and productivity variables are not exogenously determined. Most notably, the influence of factors related to the brood cows are not yet incorporated into the model. This shortcoming must be addressed, as the brood cattle are the foundation of several of these costs as well as the total production level of the cow-calf enterprise.

Figure 2 shows the interactions that the variable for number of brood cows, or herd size, has with several other variables in the model. This variable influences the BE of the cow-calf enterprise by its indirect relationships with both costs and production. The importance of herd size on ranching profitability was motivated by the review of literature, which indicated that herd size can play an important role, even though its influence on economic efficiency is still open for debate (Langemeier, McGrann and Parker, 1999; Ramsey et al., 2005; Leung, Kulshreshtha and Brown, 1991; Short, 2001; Featherstone, Langemeier and Ismet, 1997; Jones 2000; Samarajeewa et al., 2012; Nehring et al., 2014).

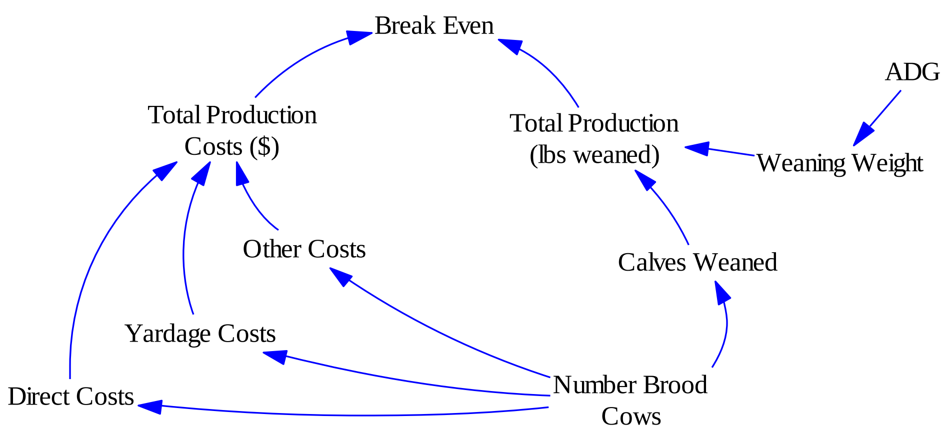

Figure 2. Exogenous and Endogenous Break-Even Drivers

4 Cost of Compliance Break-Down

The average response of steer calves to either zeranol or progesterone estradiol-benzoate combination implants is an addition of 0.10 lbs to their average daily gain (ADG)[4], while heifers tend to be slightly higher, at 0.12 lb (Selk, 1997). Thus, a decline in biological performance results when GEP use is foregone, decreasing total production, ceteris paribus. Generally, improved biological performance reduces per-head COP, especially when comparing producers operating under similar climatic conditions (Alberta Agriculture and Rural Development, 2011; Ramsey et al., 2005; Samarejeewa et al., 2012). Therefore, the model in figure 2 needs to be adjusted to reflect the difference in total production when GEPs are used.

Purchasing GEPs represents an additional direct veterinary cost, and administering them requires labour, which both potentially increase COP. While there would technically be labour charges for administering the implant, we feel that this cost is negligible at the individual animal level. The reason for this is that the implant is typically administered in combination with other routine processes at 2 months of age, meaning that much of the cattle handling occurs regardless, and implantation requires only a few seconds per animal (Selk, 1997). The interaction between GEP usage and cost of compliance will include the cost of purchasing these implants, not the negligible labour expense, and will be added to the direct costs component of the model depicted in Figure 2.

Abstaining from GEP use is just one component of the program. Assurance that the calves were not implanted is also required, which relies heavily on identification and records to be maintained by the producer. Therefore, producers enrolling their calves in the EU program to access this marketing channel must take on an additional administrative labour burden beyond what is required for selling calves through conventional channels.

It is mandatory for Canadian cattle to carry an approved radio frequency identification (RFID) tag, shown in Figure 3, prior to leaving their farm of origin to comply with the Canadian Cattle Identification Agency (CCIA) traceability program that is currently in place. Each RFID tag is embedded with a unique identification number, which is recorded in the national database along with the information of the producer to which it was issued through the tag distribution network (Canadian Cattle Identification Agency, 2009). As compliance with the CCIA program is already mandatory, the traceability requirements for EU compliance do not present an additional cost to cow-calf producers.

Figure 3. RFID Tag
Source: Author's photo

However, not all producers will have practices in place for automatic compliance with the relatively greater ID requirements of the EU program (Manglai, 2016). Having a second form of ID cross referenced to the RFID tag is the common practice for existing participants in the program. Typically an individual management tag identifier, as pictured in figure 4, would be used to cross reference, as well as aid in other management activities (Faintuck, 2017; Fenton, 2017; Hagel, 2017; Kostelansky, 2017). This enables cattle to be more easily distinguished from one another upon visual inspection and enables the proper filing of an RFID tag replacement report, shown in Appendix A.

[4] Average Daily Gain is the difference between weights on two different dates, divided by the number of days between those dates. Other countries may use Daily Weight Gain or other similar terms.

Figure 4. RFID (left) and Management Tag (right)
Source: Author's photo

The subsequent burden for producers once adequate identification procedures are in place is the maintenance of inventory records. EU certification requires that records of animals enrolled in the program must be kept for at least three years by the farm of origin from the date that the calves were born. An additional task is required of producers wishing to enroll, as they will need to fill out the Register for Birth Farms, a list of the approved tag numbers of the calves enrolled in the program, which need to be linked to a transfer certificate number and date. The transfer certificate, is another piece of documentation which the producer is responsible for completing prior to transferring the calves to another farm, feedlot, or auction market. This documentation is specific to EU program enrollment only, thus presenting a new additional administrative cost to producers (Canadian Food Inspection Agency, 2016). These tasks are not required for conventional marketing channels, thus an increase in labour expenses is expected to be associated with program compliance.

5 Compliance Scenarios

To reflect a realistic cost for complying with the EU program requirements, more than one scenario must be taken under consideration as cow-calf production practices can vary widely. Some practices bring production regimes either closer to – or further from – meeting the compliance requirements. As a result, certain subsets of producers face a smaller incremental change to their production practices than others when adjusting their management practices to comply with the program. Break-even prices are simulated to reflect the COP under both status-quo and EU compliance production regimes. The difference in BE before and after compliance represents the price premium needed by the producer to cover additional expenses and make them indifferent between enrolling in the program and their status-quo from a profit perspective.

Certain components of production costs will apply consistently to all scenarios, regardless of the production adjustments being made. First of all, the costs directly related to the maintenance of the brood cows will be equivalent across scenarios. EU compliance is concerned solely with the practices administered to the calves which are intended to enter the production chain that leads to their export. Certain elements of compliance will apply consistently across firms, regardless of the production practices already in place. These concern the administrative labour involved in maintaining the documentation that is specifically for maintaining status in the program and the CFIA inspection which enrolled producers are subject to at least once per year.

5.1 Scenario A

Scenario A is a representation of the compliance models which would be considered 'least complaint' with EU standards, which can be thought of as operations that must undergo the largest adjustments to their existing procedures to meet EU specifications. It assumed in this case that these producers are utilizing growth enhancing products and meeting the minimal requirements for traceability and identification protocols. For this group to conform to the program, they will suffer a loss in productivity by foregoing the implant. As they will no longer be implanting GEPs, they will no longer need to purchase the implants, therefore there will be a decrease in veterinary expenses.

The second adjustment to their existing protocols is the implementation of an alternative ID system. This group will need to expend additional labour hours to complete the task of applying an alternative individual ID to their calves so that it can be cross-referenced with the RFID tag.

5.2 Scenario B

Scenario B represents production systems that are considered 'partially compliant', in the sense that producers within these systems already partially meet the requirements for becoming EU certified as they already have an alternative ID system in place in addition to standard traceability obligations. Therefore, in making the necessary adjustments these producers are only foregoing the use of hormone implants, which affects productivity and veterinary expenses. Implementing an alternative tagging ID system does not present an additional cost associated with EU compliance for this scenario, as this labour cost was already being incurred regardless of their status in the program.

5.3 Scenario C

Scenario C also represents a group of partially compliant producers. In this case, the producers already have chosen to forego the use of hormone implants, which means that adhering to the program requirements will not affect their existing productivity level. That is to say that these producers were already foregoing additional gains that could be achieved through the use of hormone implants. However, these producers are assumed to RFID tag their calves in the spring and do not have an alternative ID system in place, which is an incremental labour expense they would have to incur if they were to join the program.

5.4 Scenario D

Producers within Scenario D represent those that already have in place most of the required practices to meet the program requirements. This group has already foregone the use of hormone implants and already has in place an alternative ID system. Therefore, their productivity and ID protocol expenses are expected to remain consistent following the transition to EU compliance. In this case, the administrative costs related to maintaining the program-specific documents and the time required for the annual inspection are the only remaining additional costs that compliance will present. This cost applies to all the other scenarios as well.

Table 2 summarizes the scenarios and the adjustments that would need to be made if a producer were to enroll in the EU program. Each 'X' in this table represents an area of their typical production processes that would need adjusting, resulting in a change to their existing production costs. As can be seen, the CFIA program-specific documentation maintenance and the inspection present costs to all producers regardless of their existing practices or status in the program.

Table 2.
Summary of Compliance Scenarios

	Compliance Scenario			
	A	**B**	**C**	**D**
Implant Calves	X	X	-	-
RFID Tag Only	X	-	X	-
CFIA Inspection & Paperwork	X	X	X	X

6 Systems Model

Illustrated in Figure 5 are the drivers of COP that will be considered in this analysis and how the previously discussed compliance requirements are related to them. Each part of this system influences the BE required for a cow-calf operation and can be adjusted to mimic each compliance scenario. This provides a framework to estimate the premium necessary to procure a supply of EU complaint calves as the additional revenue from participation in this marketing channel must cover the costs incurred to comply (Brocklebank, 2004).

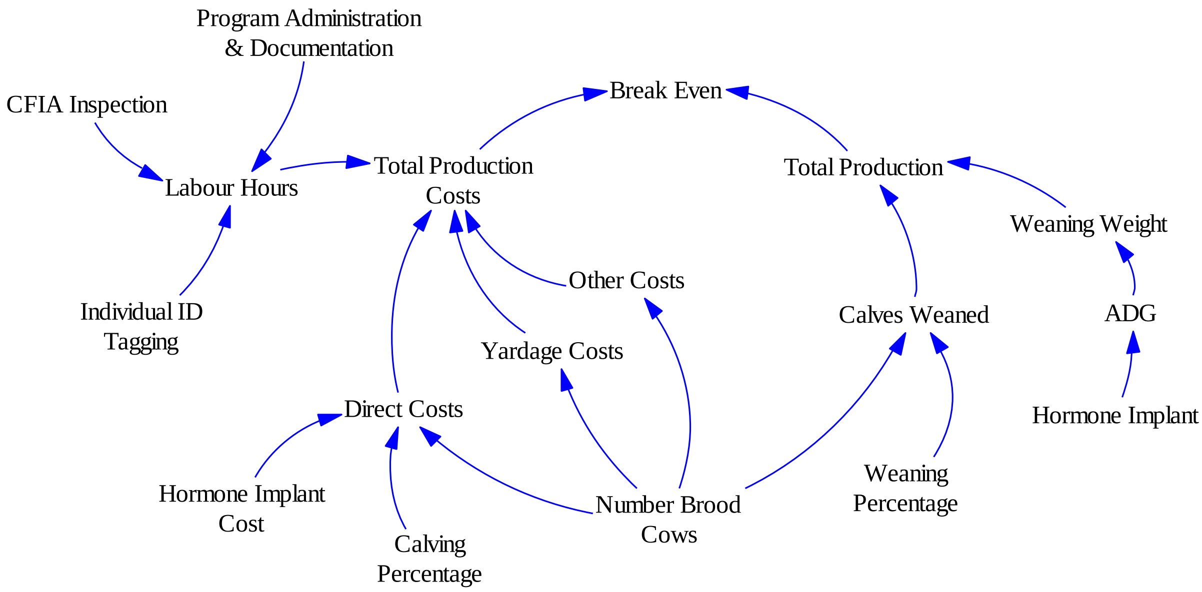

Figure 5. Conceptual Model

We used the PLE version of the Vensim software program (Ventana Systems Inc., 2015) to build and simulate the model. Besides having the capacity to build and simulate systems models, this software had a 'Synthesim' function, which facilitated sensitivity analysis by enabling the user to simultaneously alter parameter values and see instantaneous changes to the results. Described throughout the remainder of this section are the assumptions underlying the parameter values and equations used to develop a usable model, and a tabulation of all the elements used as inputs into the Vensim software.

Approximately 75 percent of all Canadian beef calves are produced in the western Prairie Provinces of Alberta, Saskatchewan, and Manitoba (Statistics Canada, 2017). The COP data used to parameterize the cost components of the BE model includes the WBDC's 2012 Saskatchewan Cow-Calf Cost of Production Analysis (Larson, 2013) and Alberta Agriculture and Forestry's AgriProfit$ Multi-Year Economic, Productive & Financial Performance of Alberta Cow/Calf Operations (Alberta Agriculture and Forestry, 2016). Both reports use survey data from producers in their respective provinces who voluntarily offered to provide information regarding their cow-calf operations. The WBDC survey was conducted for the 2012 production season, whereas Alberta Agriculture and Forestry has surveys spanning several years. For the development of this BE model, data from the common year, 2012, will be used. Also to be taken from these surveys is the required productivity data, as variables such as herd size and weaning weight are related to COP. Due to the relationship between productivity and profitability, the productivity parameters in the model must correspond with the COP data.

The data contained in these COP budgets for Alberta and Saskatchewan need to be combined in some way to reflect an average cost and productivity values for a typical producer in western Canada. To do so, a weighted average approach will be taken using information from the 2011 Census of Agriculture. These data indicate that when considering only the Saskatchewan and Alberta beef herds, Saskatchewan is home to 42 percent of beef cows and Alberta is home to the other 58 percent (Statistics Canada, 2017). These proportions will be used to weight the data from each province when an average is being calculated. Summarized in Table 3 is the COP survey results for Saskatchewan and Alberta individually, as well as the weighted average COP (Larson, 2013; Oginskyy, 2017).

Table 3.
Provincial COP Survey Results

	Saskatchewan	**Alberta**	**Weighted Average**
# of brood cows	354	198	264
	Costs ($/brood cow)		
Winter Feed	$189.14	$277.44	$240.35
Grazing	$125.74	$218.16	179.34
Veterinary & Medicine	$25.46	$18.49	$21.42
Breeding Stock	$52.47	$0.73	$22.46
Total Direct Costs (A)	**$392.80**	**$514.82**	**$463.57**
Fuel	$25.62	$13.95	$18.85
Machinery Repairs	$17.71	$11.47	$14.09
Building & Corral Repairs	$9.58	$4.41	$6.58
Utilities & Misc.	$21.04	$15.33	$17.73
Custom Work	$8.75	$5.75	$7.01
Paid Labour	$11.23	$13.26	$12.41
Unpaid Labour	$71.70	$31.47	$48.37
Taxes/Lic./H20	$8.86	$7.95	$8.33
Depreciation	$37.19	$34.94	$35.89
Lease Payments	$1.21	$1.00	$1.09
Total Yardage Costs (B)	**$212.90**	**$139.53**	**$170.34**
Capital Interest	$6.00	$3.70	$4.67
Operating Interest	$7.46	$1.01	$3.72
Trucking/Marketing Costs	$37.19	$12.15	$11.80
Share/Lease Cattle Payments		$1.99	$1.15
Total Other Costs (C)	**$24.78**	**$18.85**	**$21.34**
Total Costs (A+B+C)	**$630.47**	**$673.20**	**$655.26**

1 – Winter feed includes bedding
2 – Grazing includes salt and mineral
3 – Bull rental/Breeding fee

6.1 Exogenous Variables

The variables summarized in Table 5 represent the system boundaries. These variables are considered exogenous in the sense that they are determined outside of the system, and so they are parameterized using values that are taken as a given.

The binary decision variables indicate a choice to be made by the producer. These variables will take on a value of 0 if the protocol of concern is not being implemented, and 1 if it is. They will interact with the equation set up for the endogenous variables to turn additive parts of that equation 'on' or 'off', depending on whether the decision variable takes on a value of 0 or 1. This will allow several simulations to be run using the same model, but with different combinations of management decisions being made, thus enabling the simulations of BE for the scenarios described.

Hormone Implant – this variable will be set to a value of 1 if the producer implants their calves, and 0 if not. The assumption made here is that producers enrolling in the program will forego the use of implants for all of their calves (Faintuck, 2017; Fenton, 2017; Hagel, 2017; Kostelansky, 2017). This binary variable interacts with three endogenous variables; direct costs, labour costs and total production, which has already been discussed.

Purchasing GEPs affects the veterinary expense category, which is a component of direct costs. Price data was gathered from retailers located in Saskatchewan and Alberta which handle suckling calf implants. The most commonly offered implant product was Ralgro. No price information was found for Component E-C, but information for its 'look-alike', Synovex-C, was obtained. These products are summarized in Appendix A, with the average price across them being $1.72 per dose. This price will be multiplied by the binary decision variable for implanting, as well as the calving percentage since only live calves at spring processing will be implanted and be added to direct costs.

Individual ID Tagging – When this variable equals zero, it indicates that the manager chooses to not use an alternate individual ID system. Individual ID tagging affects two endogenous variables: labour and direct costs. This task is assumed to take approximately 5 minutes per calf, and requires two people[5]. This amounts to 10 minutes of total labour required per calf to individually ID tag. There is also an expense associated with purchasing the tags. Management ID tag prices range from $1.28 to $1.68, depending on brand and size[6]. Therefore, an average price of $1.48 per tag is assumed.

CFIA Inspection, Program Administration and Documentation – An important assurance of compliance is an annual on-site assessment conducted by a CFIA approved veterinarian. Typically, these visits occur once per year for producers that are familiar with the program and require 1.5 hours to complete (Canadian Food Inspection Agency, 2016; Faintuck, 2017; Fenton, 2017; Kostelansky, 2017).

This binary decision variable will be associated with a veterinarian service and mileage fee. Using a general professional rate from the Saskatchewan Veterinary Medicine Association's rate guide, which is $249.00 per hour, the time for the inspection is estimated to be valued at $373.50. In addition to that, the veterinarian would need to charge mileage for travelling out to the farm to conduct inspections. To value this expense the base mileage rate of $59.90, which applies for travel to all sites within 18 km, is used. Thus, the total annual charge for the veterinarian inspection is estimated to be $433.40. It should be noted that this estimate may be under-valued when using only the base mileage rate, as cow-calf production takes place over a very wide geographic area in western Canada.

Producers are also responsible for the maintenance of accurate inventory records and adequate documentation in addition to what is typically required to market calves via conventional channels (Canadian Food Inspection Agency, 2016). However, with the use of computers, meeting this requirement is not a highly time consuming task. Conversation with a currently enrolled producer suggested that approximately an hour per year is all the time needed, in addition to inspection, for completing the CFIA administrative component of the program (Hagel, 2017). Therefore, a total of 2.5 hours per year is assumed to be the additional labour time requirement for enrollment.

The final model is shown in Figure 7. Data from various sources was organized and applied to the systems model in a manner that is intended to mimic BE determination in reality. The parameters as they will appear in the actual computer model and the information sources for their creation are summarized in Table 4 and Table 5.

[5] This estimate is a result of conversations with various producers and the Western Beef Development Centre.

[6] Price information was gathered from livestock supply retailers including: United Farmers of Alberta, Peavey Mart, and Canadian Co-operative Wool Growers.

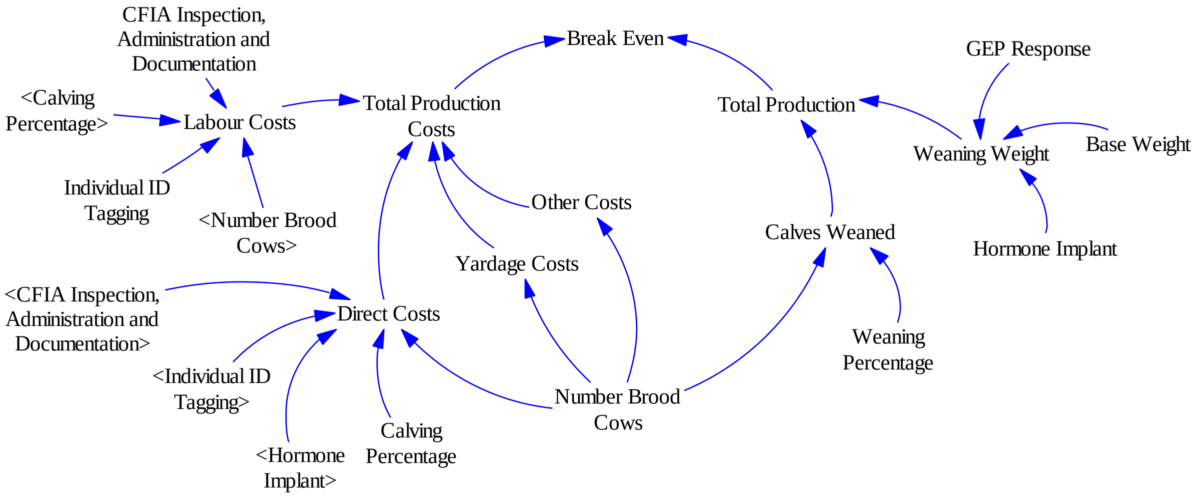

Figure 5. Structure of Empirical Model**7**

Table 4.
Exogenous Variable Summary

Exogenous Variable	**Value**	**Units**
# Brood Cows	264	Animals
Base Weight	546	Pounds
GEP Response	18	Pounds
Weaning Rate	87.2	%
Calving Rate	90.9	%
Hormone Implant	0,1	Binary Variable
Individual ID Tagging	0,1	Binary Variable
Fall RFID Tagging	0,1	Binary Variable
CFIA Inspection	0,1	Binary Variable
Program Admin. & Documentation	0,1	Binary Variable

[7] This figure depicts the model as it appears in Vensim. The angle brackets that surround some of the variables indicates the use of a 'Shadow Variable', which means that this variable is an exact copy of another variable in the system, and that its definition can be found by opening up the details for the originally created variable.

Table 5.
Endogenous Variable Summary

Endogenous Variable	Equation	Unit
Weaning Weight	= Base Weight + GEP Response * Hormone Implant	Pounds/ animal
Calves Weaned	= # Brood Cows * Weaning %	Animals
Total Production	= Calves Weaned * Weaning Weight	Pounds
Direct Costs	= (461.94 + 1.72 * Hormone Implant * Calving Percentage + 1.48 * Individual ID Tag * Calving Percentage) * # Brood Cows + (CFIA Insp. & Admin * 433.40)	$
Yardage Costs	= 109.56 * # Brood Cows	$
Other Costs	= 21.34 * # Brood Cows	$
Labour Costs	= ((7.86 + Individual ID Tag* 0.17* Calving Rate) * # Brood Cows) * 24 + (CFIA Insp. & Admin. * 2.5) * 24	$
Total Costs	= Direct Costs + Yardage Costs + Other Costs + Labour Costs	$
Break-Even	= Total Costs / Total Production	$/pound

7 Results

The estimated BE price for western Canadian cow-calf producers following EU compliant protocols is estimated to be $1.6525 per pound. All production scenarios are compared to this compliant BE value to estimate the required price premium for producers in that group.

The results for each simulation are summarized in Table 6. Reported in the third column are BE differences between the status quo, or 'base' production scenarios and that of the EU compliant scenario. This measure quantifies the profitability impact of transitioning from status quo practices to those required for EU certification. A larger difference indicates a larger degree of change to the existing management practices and productivity level to meet certification requirements. If a producer had already implemented a practice required under the EU program prior to enrolling, the cost of that practice is not reflected in the BE difference.

The fourth column shows the required premium on a per-calf scale. These values represent the additional revenue that the producer would need to earn over what they would at their initial break-even price, but meeting the elements required to enroll in the program. For producers in scenario A & B, this value includes a premium to compensate for losses in production. The BE difference value reflects a point where producers would be indifferent.

Table 6.
Summary of Results

Scenario	BE ($/lb)	BE Difference ($/lb)	BE Difference ($/calf)
EU Compliant	$1.6559	-	-
Scenario A Base	$1.5922	$0.0637	$34.78
Scenario B Base	$1.6025	$0.0534	$29.16
Scenario C Base	$1.6414	$0.0145	$7.92
Scenario D Base	$1.6520	$0.0039	$2.13

7.1 Scenario A

Amongst all simulations, Scenario A has the smallest base BE of $1.59 per pound. As the producers in this group take advantage of growth enhancing products and have no additional labour expenses associated with management tagging, for them to have the lowest BE is expected. As a result of this low initial case BE, the per-pound BE difference for supplying to the EU marketing channel is largest for scenario A, at 6.37 cents per pound more than they were initially.

Producers within Scenario A would incur a loss of $34.78 per calf as a result of increased production costs and reduced productivity if they continued to earn their initial BE price while enrolled in the program. In the context of the cow-calf enterprise as a whole, this premium indicates that the producer would need to earn approximately $8000 more revenue for their herd of 264 brood cows. Although this premium may seem quite large, compared to the total revenue for the calf crop, it amounts to only 4 percent.

7.2 Scenario B

Scenario B reflects a 'partially compliant' producer that already has an alternative ID system in place, but also implants their calves. Therefore, the base BE of $1.60 per pound for scenario B is slightly larger than that of A. Scenario B producers would require a smaller premium of 5.34 cents per pound to cover their costs and loss in productivity to maintain normal profits. The per-calf premium required to maintain a zero-profit level, is estimated to be $29.16[8] for scenario B producers, which results in approximately $6700 for the entire calf crop.

7.3 Scenario C

In this case, the producers have already elected to forego the hormone implant regardless of their status in the program but have not implemented alternative ID tagging. Therefore, no difference in production would be observed for this group, but they would face higher labour expenses. The base BE for scenario C is $1.64 per pound, thus the estimated premium required by this group is an additional 1.45 cents per pound over what they earned before to cover their new expenses.

Since this group does not experience a decline in production when switching to EU complaint production, the per-head premium shown in column four is much smaller than for scenarios A or B. The per-calf premium value in this scenario, $7.92[9], only reflects the impact that compliance has on production costs as there is no loss in productivity. In the context of the whole cow-calf enterprise, this translates into a premium of approximately $1823 for the entire calf crop.

7.4 Scenario D

This final scenario was structured to represent producers that are nearly compliant with EU standards. Essentially, they only need to undergo CFIA inspection and documentation procedures to enroll in the program, the costs of which are distributed over the entire calf crop. Therefore, it is unsurprising that the premium estimated for this group is very small, at only 0.39 cents per pound and the per-calf premium is

[8] $0.0534 * 546 pounds = $29.16, $904.13 – (546 * $1.6025) = $29.16
[9] $0.0145 * 546 pounds = $7.92, $904.13 – (546 * $1.6414) = $7.92

also small, at only $2.13 per animal[10]. In terms of the entire calf crop, the required premium for these producers is only an additional $490 in revenue.

8 Implications and Limitations

Over a five-year period, the Canadian beef industry will gain duty-free market access into the EU for 64,950 tonnes of beef (carcass weight equivalent) once the CETA comes into force. Using standard carcass yield amounts, a minimum of 157,000 certified cattle would need to be available to fill this quota. That number is likely much higher as not all cuts in the carcass may be imported by EU buyers. The results indicate that a subset of producers, which follow the protocol defined for Scenario D, would require a very small premium to overcome the cost of compliance with EU marketing channel standards. Therefore, a subset of western Canada's beef producers is well positioned to enter the EU marketing channel.

Between the largest cattle producing provinces in western Canada, Saskatchewan and Alberta, there are approximately 2.6 million beef cows, managed under one of the four scenario groups defined (Statistics Canada, 2017). Using this inventory, supply capacity for the EU market channel within each category is estimated using adoption rate data for the management practices of interest. In western Canada, 93 percent of producers maintain individual calf ID records, and 24 percent implant their calves (Manglai, 2016; Western Beef Development Centre, 2015). Assuming no correlation between these adoption rates and herd size, the estimated portion and inventory of calves produced annually within each management scenario is summarize in Table 7.

Table 7.
Supply of Calves

Scenario	Portion of Calves[11]	Number of Calves Produced
A	1.68%	38,888
B	22.32%	516,654
C	5.32%	123,145
D	70.68%	1,636,072

Scenario D producers have the smallest cost of compliance while also corresponding to the largest supply of beef calves. The estimates in Table 7 indicate that the Scenario D producers would have ample inventories of nearly compliant beef calves to supply the marketing channel for EU export. The implication of these results is that the western Canada cow-calf segment of the beef supply chain could benefit from having access to an alternative marketing channel. Access to a marketing channel for EU certified calves may enable them to reduce financial risk with production contracts, or seek out a price premium for their EU certified beef calves.

While these estimates indicate much opportunity for western Canada's cow-calf producers, they must be interpreted with caution for reasons related to the nature of the data which parameterized the model. Firstly, the cost of production data is collected via survey from voluntary respondents. This means that some self-selection bias may exist where producers with certain characteristics may be more inclined to prticipate and therefore introduce some bias into the data. Secondly, production costs can be highly influenced by environmental factors. Since producers from diverse ecological regions may have participated, the resulting averages likely will not reflect individual situations accurately.

The supply estimates in Table 7 may also have some inaccuracies resulting from the assumption of uncorrelated adoption rates and herd sizes. This assumption was made for lack of adequate data to determine if there is a significant correlation.

[10] $0.0039 * 546 = $2.13, $904.13 – (546 * $1.6520) = $2.13
[11] Portion was calculated by multiplying together the adoption rates of the practices associated with that scenario.

However, there is some evidence of a relationship existing between the adoption of various production-enhancing practices and herd size (Nehring et al., 2014). If this is the case in western Canada, then the supply estimates for each production scenario group may be inaccurate.

9 Conclusions

The potential benefits of trade with the EU can only be fully realized if the tariff-free quota is filled. While the CETA has been met with enthusiasm by the industry, beef trade between Canada and the EU has historically been constrained by several technical barriers (Canadian Cattlemen's Association, 2014; Canadian Food Inspection Agency, 2016). Increased access to the EU market with the implementation of the CETA may be a profitable opportunity for the Canadian beef industry, but there are certain costs imposed on producers that wish to participate. For cow-calf producers, use of any growth enhancing products on cattle destined for the EU is strictly prohibited. To ensure this protocol is being followed, the CFIA has in place a program for certifying GEP free beef. Essentially, this program relies on a combination of approved veterinarian inspections, identification procedures and documentation to gain adequate assurance that the producer has complied with the no GEP stipulation. Therefore, the costs of compliance are imposed on cow-calf producers in two ways: a loss of productivity when GEPs are foregone and additional labour to complete the administrative requirements for enrollment in the program. The premium required for EU certified production to maintain normal profit was estimated by simulating the BE price under typical production practices as well as under program compliant practices and calculating the difference between them

The findings of this research suggest that entering differentiated beef marketing channels, such as the EU certified GEP-free channel, may be an economically viable decision for some cow-calf producers. As there is a large degree of variability between producers in the cow-calf segment, enrolling in this program can be achieved at little additional cost, depending on the production practices already in place. For the 76 percent of cow-calf producers that already choose to forego GEPs, entering the EU channel may enable them to earn a premium for voluntarily foregoing profit-enhancing practices. Especially in this case, differentiated marketing could compensate producers for lost productivity when electing to not implant. Thus, for the 70.68 percent of producers in western Canada that fall into the Scenario D, pursuing the EU marketing channel may be an attractive opportunity.

However, it is not likely that live cattle will be shipped to the EU (Deblitz and Dhuyvetter, 2013), therefore the real costs might be associated with coordinating the sourcing and movement of animals that meet production standards for various markets. This means that the rest of the Canadian beef supply chain needs to also enter the channel before cow-calf producers could benefit from this trade opportunity. Feedlots would also suffer a loss in productivity by foregoing GEP usage, and beef processors would need to maintain segregation of EU certified product. There needs to be adequate premium to be gained from the EU market to compensate all supply chain partners for these additional costs. This paper estimates the premium required for one part of this supply chain, but further research needs to be done for estimating the premium requirements for other partners and the overall cost of increased supply chain coordination.

Despite the potential benefits of transitioning to a more differentiated beef marketing structure, there still exists institutional constraints that will slow the process of doing so. Currently the Canadian beef supply chain is set up for an undifferentiated commodity marketing structure, and would need to undergo reorganization to become more vertically coordinated (Brocklebank, 2004). On the horizon, the western Canadian beef industry is anticipated increase capacity for processing differentiated beef products with the opening of the Harmony Beef plant near Calgary (Kienlen, 2017; Duckworth, 2017b). The intention of this plant is to enter into niche markets for beef, including processing for the EU market. Thus, the structural rigidity of Canadian beef processors, which are traditionally set up for large quantity and little differentiation, may be alleviated.

However, the commodity beef channel is not anticipated to completely give way to a more coordinated and differentiated channel any time soon. For producers that remain in the commodity beef marketing channel, foregoing the use of GEPs carries an opportunity cost. This implies that producers who remain in the commodity market channel should be utilizing GEP's to maximize the return on their cattle, as they are not being compensated for their production losses.

The Canadian beef industry should continue to pursue opportunities to enter new markets and foster the development of differentiated marketing channels. This research demonstrates that refocusing on certain production attributes can be relatively low cost for some cow-calf producers. As this segment of the supply chain tends to be heterogeneous, there is likely to exist a subset of producers that can easily transition into different niche marketing channels and begin to earn a premium for practices they already employ on their operations. The ability to target alternative markets provides producers more opportunity to compete with strategies other than cost reduction alone.

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Appendix A – Approved Products for Suckling Calves in Canada

Product	Active Ingredient	Approved Use	Price
Ralgro	36mg zeranol	Nursing steer calves and heifers intended for breeding > 30 days old to weaning	$1.45/dose
Synovex-C	100mg progesterone & 10mg estradiol benzoate	Nursing steer calves and heifers intended for breeding > 45 days old to < 410lbs	$1.30/dose
Compudose	24mg estradiol-17 beta	Steers > 175 lbs, not for use in heifers intended for breeding	$2.40/dose
Component E-C	100mg progesterone & 10mg estradiol benzoate	Nursing steer calves and heifers intended for breeding > 45 days old to < 410lbs	N/A
Source: Alberta Cow-Calf Guide; various veterinarian clinics and farm supply retailers			