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Resources Inventory of Beef and Dairy Operations for the Use of Ethanol Coproducts

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Abstract: To remain competitive in the industry, beef and dairy producers in the Midwest need to adapt to the use of alternative feeds and take advantage of the expected abundance and favorable pricing of biofuel coproducts. Integrating the coproducts as feed ingredients could make the livestock industry significantly more attractive and competitive in domestic and global markets. A survey instrument was created to inventory resources that currently limit (or enable) the use of biofuel coproducts by small and medium-sized beef and dairy producers in the state of Indiana. Seventy-eight of Indiana's 92 counties were represented in the survey results.

Introduction

The biofuel industry is driving an exceptional change in animal agriculture across the United States. The growing corn ethanol and soy-diesel industries provide significant benefits to grain producers, but projected increases in feed prices and a lack of suitable alternative energy-dense feedstuffs delineate new challenges for the traditional livestock sector.

Corn-based ethanol production not only results in the production of ethanol fuel, but also in a high-protein, high-energy livestock feed product (Buckner, Mark, Bremer, & Erickson, 2008). Studies on the value of ethanol coproducts as livestock feed highlight the importance of finding new alternatives to integrate these coproducts efficiently, effectively, and profitably into beef and dairy diets, taking into consideration variation in nutrient digestibility and availability of ethanol coproducts. The first management priority identified by producers and specialists in the beef industry was herd nutrition (Field, 2006) and for the dairy industry the inclusion rate of distiller's grains in the diet and the variability of dry matter (Kalscheur & Garcia, 2004).

For the state of Indiana, the livestock industry is an important source of employment and economic activity. In 2007, the four largest livestock sectors combined (beef, dairy, pork, and poultry) created an economic impact on Indiana with nearly 6 billion dollars that generated employment for more than 35,000 people (Mayen & McNamara, 2007). According to the United States Department of Agriculture's National Agricultural Statistical Service, Indiana has approximately 12,700 beef cow operations, which translate into 235,300 beef cows, and over 2,000 dairy farms, for a total of 166,150 milk cows (USDA-NASS, 2007).

Identifying and inventorying resources of beef and dairy operations in the state of Indiana can serve as a guide to develop and implement educational programs that will impact the use of biofuel coproducts by small and medium-size beef and dairy producers. These opportunities need to be addressed from an interdisciplinary approach aimed at stimulating industry participants into becoming more competitive and efficient in today's volatile markets.

To understand producer perspectives, a survey instrument was developed to assess the attitudes and the potential for biofuel coproducts use among beef and dairy producers for the state of Indiana. The characteristics of farm operators provide valuable information that describes the type of individuals surveyed and this information can be used for outreach programs and awareness (Soumare & Chembezi, 2002).

Information on current storage systems, available technology, and resources should provide a better understanding of critical control points that enhance or prevent the use of biofuel coproducts in the area.

Materials and Methods

The evaluation design was based on a quantitative approach using data analysis of participants' responses to specific items (see survey questions below). One survey was conducted using a paper-based survey research design following the Tailored Design Method (Dillman, Smith, & Christian, 2008). The survey instrument was created to inventory resources that currently offer challenges and opportunities for the use of biofuel coproducts by small and medium-sized beef and dairy producers. The questions for the research survey were chosen based on a focus group of Extension agents and faculty interested in learning more about producers' attitudes and willingness to integrate biofuels coproducts into beef and dairy diets. Questions were reviewed by a small focus group of Extension educators and a survey expert from

Agricultural Education at Purdue, previous to the distribution period of 2006.

The paper survey was inserted into the conference program packets distributed to attendees during 10 regional beef meetings and five regional dairy meetings in order to retain as many surveys as possible from both industries in the years of 2006 and 2007. Based on the organization and location of the regional beef and dairy meetings, it is highly unlikely that participants took the survey twice. In addition, the survey included a preface statement "please only complete at one meeting location." This disclosure was included to ensure single participation. To collect the surveys, a box for completed evaluations was prominently displayed in several locations at each conference location, including the registration table. Facilitators at the conferences announced at the closure of the final session to hand in completed questionnaires before leaving the conference. In addition, the sample population is assumed to represent progressive thinking producers willing to attend extension meetings and embrace new technology.

Respondents represented 414 different operations. Based on survey responses, 68 dairy operations and 337 beef operations were represented on the population sampled.

The instrument contained 22 questions related to the following aspects:

- Demographic characteristics
- Resources available
- Production (characterization and average herd size)
- Production goals
- Management practices
- Soil quality and environmental concerns.

The information provided on storage systems, available technology, and current resources in place on small and medium-sized farms could be used as a platform to optimize feeding strategies for biofuel coproducts, especially coproducts from the ethanol production.

Survey Questions

The study considered twenty-two research questions (the survey was re-formatted to save space for publication purposes), and it follows in Figure 1.

Figure 1.
Survey Assessing Attitudes About and Potential for Biofuel Coproducts Use Among Beef and Dairy Producers in Indiana

1. Age of principle operator:	<25 25-34 45-44 55-64 65-74 >75

2. Acres available for manure application:	
3. County of primary operation:	
4. Approximate corn yield in local surrounding area:	
5. Herd size (circle all that apply): **Developing heifers** <100 100-199 200-299 300-1000 >1000 **Feedlot calves** <50 50-99 100-299 300-1000 >1000	**Dairy cows** <100 100-199 200-299 300-700 >700 **Beef cows** <25 25-50 50-100 100-200 >200

6. Equipment (check all that apply):
Stationary mixer
Mix Wagon for TMR
Tub grinder/bale processor
Skid steer
Hammer mill grinder/mixer
Front end loader

7. Feed storage system (check all that apply):
Upright silo (top or top unloader)
Supplement bin
Other
Agbag
Commodity bay
Trench/bunker silo

8. What are you basal ingredients? (check all that apply):
Corn
Haylage (grass and/or legume)
Alfalfa hay
Soybean meal
Wet distiller's grains
Wet corn gluten feed
Corn stalks (grazed or baled)
Corn silage
Grass hay
Mixed hay
Commercial (purchased) protein supplements
Dry distiller's grains
Dry corn gluten feed
Straw (wheat or oat)

9. Average characterization of production(circle all that apply):
Feedlot ADG (lbs/day):
2.0 2-2.5 2.5-3.0 3-3.5 >3.5
Dairy milk production (lbs/day):
90
Average mature cow weight (lbs):
1400
Heifer Development ADG (lbs/day):
2.0
Beef weaning weights (lbs):
600

10. Is the cattle operation a primary source of income? Yes No

11. Do you routinely keep records that provide unit cost of production/break even cost? Yes No

12. Do you routinely test soils for Nitrogen (N), Phosphorous (P), and Potassium (K)?	Yes No
13. Do you routinely apply manure based on soil tests?	Yes No
14. Do you routinely test your manure for nutrient analysis?	Yes No
15. Do you have a formal nutrient management plan?	Yes No
16. Have you ever fed coproduct feeds?(check all that apply): Potato Gluten feeds Brewer grains Others	Bakery Distiller's grains Soybean hulls Starch byproducts
17. Have you ever considered feeding one of these coproducts?	Yes No
18. If no, why not? (check all that apply): Storage facility Product quality/consistency Other	Size of operation Equipment (handling, processing, storage, etc.) Cost
19.Animal feeding facilities (check all that apply): Portable bunks Self feeders (steer stuffers) Other	Automated bunk feeding system Drive through feed alley/fence line bunk
20.How are you feeding energy/concentrates? (check all that apply): Included in total mixed ration (TMR) Fed separately (bunk, milk, parlor, etc.)	Top dressed Other
21.Are feed ingredients weighed by?(check all that apply): Scale Estimated by bucket, scoop, shovel, etc.	Volume Other
22. Are you routinely using feed additives, BST, implants? Feed additives (antibiotics, ionophores, coccidiostats, etc.)	Implants BST

Analysis:

The data were analyzed using SAS® Software (SAS Institute, Cary, NC) with a frequency and cross frequency count. Any incomplete questions or confusing marks and answers were treated as missing values and were not included in the analysis.

In an attempt to explore the links between the availability of ethanol coproducts and the potential use of these as feed alternatives, an analysis of the ethanol plants location versus the location of the participants operation was taken into consideration after surveys were completed. The information about participants' operations locations were divided in three different categories:

- Operations within counties with an ethanol plant.

- Operations within counties that border counties with an ethanol plant.

- Operations within counties with no ethanol plant or no borders with counties with ethanol plants.

The following thirteen ethanol plants across the state of Indiana were considered for the analysis (Indiana State Department of Agriculture [ISDA] 2009):

- Altra (Putnam County)

- Cardinal Ethanol (Randolph County)

- Central Indiana Ethanol (Grant County)

- Indiana Bio-Energy (Wells County)

- Iroquois Bio-Energy (Jasper County)

- New Energy (St. Joseph County)

- POET Biorefining (Madison, Wabash and Jay counties)

- The Andersons (Cass County)

- Verasun (Montgomery County)

- Abengoa Bioenergy Indiana and Aventine Renewable Energy (Posey County).

Additionally, two ethanol plants from the states of Illinois and Kentucky were considered for the analysis as a function of their proximity to some counties in Indiana: Parallel Products (Jefferson County, Kentucky) and Lincolnland Agri-Energy (Palestine County, Illinois) (Renewable Fuels Association, 2009)

Survey Responses

The majority of the surveyed participants' ages fell between the ranges of less than 25 years old (1.8%), 25-34 years old (5.8%), 35-44 years old (16.5%), 45-54 years old (33.3%), 55-64 years old (26.5%), 65-74 years old (12.5%), and greater than 75 years old (3.8%).

Seventy-eight of Indiana's 92 counties were represented in the survey results. The counties with the greatest representation of participants were Kosciusko county (6.97%), Elkhart county (5.77%), Cass county (5.05%), and Green county (3.85%).

To identify information about the challenges and opportunities of using biofuel coproducts in beef and dairy operations, the survey included several questions related to the following:

- Average herd size and production characterization
- Animal feeding resources
- Traditional feeds and current use of biofuel coproducts

Average Herd Size and Production Characterization

Tables 1 and 2 summarize the results obtained from the questions related to herd size and average characterization of the production for dairy and beef producers, respectively. The survey asked about the average characterization of production for dairy cows, developing heifers, feedlot calves, and beef cows. The surveyed producers were permitted to circle more than one type of production. Survey respondents can be categorized as follows. Over 80% of the dairy operations reporting in this survey indicated they have less than 200 cows, and over 75% of the dairy operations indicated they have an average milk production per cow of over 60 lb per day. Among the beef feedlot respondents, over 75% indicated they have less than 100 head, with over 70% of the operations reporting an average daily gains over 2.5 lb per day. Over 85% of the beef cow calf operations reported herds of less than 100 cows with a mean cow weight of nearly 1250 lb and weaning weights just over 500 lb.

Table 1.
Average Herd Size and Production Characterization for Dairy Producers

Number of Dairy cows	**<100**	**100-199**	**200-299**	**300-700**	**>700**	
n[1] (n=68)	39	17	7	4	1	
%	57.4	25.0	10.3	5.9	1.5	
Dairy milk production (lbs/day)	**<50**	**50-59**	**60-69**	**70-79**	**80-89**	**>90**
n[1] (n=65)	5	10	32	12	5	1
%	7.7	15.4	49.2	18.5	7.7	1.5
[1] n= number of respondents						

Table 2.
Average Herd Size and Production Characterization for Beef Producers

Number of Feedlot calves	**<50**	**50-99**	**100-299**	**300-1000**	**>1000**
n[1] (n=190)	105	41	28	12	4
%	55.3	21.6	14.7	6.3	2.1
Feedlot ADG (lbs/day)	**2**	**2.0-2.5**	**2.5-3.0**	**3.0-3.5**	**>3.5**

n[1] (n=190)	8	48	84	42	8
%	4.2	25.3	44.2	22.1	4.2
Number of Beef cows	**<25**	**25-50**	**50-100**	**100-200**	**>200**
n[1] (n=337)	109	115	67	30	16
%	32.3	34.1	19.9	8.9	4.7
Average mature cow weight (lbs)	**<1100**	**1100-1199**	**1200-1299**	**1300-1400**	**>1400**
n[1] (n=345)	16	93	111	96	29
%	4.6	27.0	32.2	27.8	8.4
Beef weaning weights (lbs)	**<400**	**400-499**	**500-599**	**>600**	
n[1] (n=278)	14	93	139	32	
%	5.0	33.5	50.0	11.5	
[1] n= number of respondents					

Animal Feeding Resources

Animal feeding facilities owned by the surveyed cattle producers are illustrated in Table 3. Information related to feed equipment, storage, techniques, and measurement is also provided. The results indicate that approximately 50% of the surveyed beef producers have portable feed bunks, followed by self feeders (30%) and fence line feed bunks (24%). Beef feedlots tend to have more access to self feeders (41%), fence line bunks (32%), and automated bunk feeding systems (20%) by almost ten percentage points than cow calf producers.

Approximately 56% of dairy producers have access to fence line bunks, followed by portable bunks (41%) and automated bunk feeding systems (16%). Just under 50% of the beef producers use portable feed bunks. Nearly 70% of beef producers have access to front end loaders, and approximately 43% have access to skid steer loaders and hammer mills. Dairy producers tend to have more access to skid steer loaders (80%) than front end loaders (34%), while 47% have access to a hammer mill. Approximately 60% of the surveyed dairy producers have access to mix wagons, but less than 25% of beef feedlots and less than 13% of cow-calf operations have feed wagons available. The availability of tub grinders appears to about 10% for both beef feedlots and dairy producers and about 6% for cow calf producers.

Stationary mixers are about twice as available in dairy operations (10%) compared to beef operations (5%). Dairy producers have more access to upright silos (65%), trench/bunker silos (43%), and agbags (40%) compared to beef feedlots (34, 21, and 14%, respectively). Compared to beef feedlots and dairy operations, the cow calf producers surveyed have less access to upright silos (19%), trench/bunker silos (14%), and agbags to store harvested feeds. Commodity bays to store bulk feeds, such as coproducts delivered by truck, was most available on dairy operations (26.5%), followed by beef feedlots (19%) and cow-calf operations (14%). Supplement bins to store delivered feeds such as dry coproducts are available to 48% of the beef feedlots, 44% of the dairy operations, and 35% of the cow calf operations.

More dairy operations (66%) use total mixed rations than beef feedlots (55%) and cow calf operations (42%), while 26% of dairy operations feed concentrates separately from the forage component of the ration followed by beef cow calf operations (17%) and feedlots (13%). Between 15 and 20% of all surveyed operations top dress concentrates in the bunk. Dairy operations have greater access to scales when delivering feed (82%) compared to beef feedlots (51%) and cow calf operations (43%). When scales are not available, feeds appear to be delivered using some measure of volume.

Table 3.
Animal Feeding Resources

	Beef Producers			Dairy Producers	Beef and Dairy Producers
Animal feeding facilities:	**Cow Calf %**	**Feedlot %**	**Average Beef Producers %**	**Milk Herd %**	**Overall Avearge %**
Portable bunks	50.5	46.8	48.5	41.2	47.6
Self feeders (steer stuffers)	31.5	41.1	31.4	11.8	28.3
Drive through feed alley/fence line bunk	21.1	31.6	23.9	55.9	26.1
Automated bunk feeding system	9.2	19.5	11.4	16.2	11.6
Other	11.9	10.5	11.4	7.4	10.1
Equipment:	**Cow Calf %**	**Feedlot %**	**Average Beef Producers %**	**Milk Herd %**	**Overall Avearge %**
Front end loader	71.8	70.0	69.9	33.8	64.7
Skid steer	41.5	54.2	43.6	79.4	46.6
Hammer mill	43.3	52.1	42.6	47.1	42.8
Mix wagon	12.8	24.7	15.5	60.3	19.8
Tub grinder	6.2	10.0	7.1	10.3	7.5
Stationary mixer	5.0	4.7	4.9	10.3	5.3
Feed storage system:	**Cow Calf %**	**Feedlot %**	**Average Beef Producers %**	**Milk Herd %**	**Overall Avearge %**
Trench or bunker silo	14.0	21.1	15.5	42.7	17.4
Agbag	9.8	14.2	11.1	39.7	14.0
Upright silo	18.7	33.7	22.0	64.7	25.6
Commodity bay	14.2	19.0	14.6	26.5	15.7
Supplement bin	34.7	48.4	36.0	44.1	36.2
Other storage	23.4	24.2	23.3	16.2	19.3
How are you feeding energy/concentrates?:	**Cow Calf**	**Feedlot %**	**Average Beef Producers %**	**Milk Herd %**	**Overall Avearge %**

	%				
Included in total mixed ration (TMR)	42.4	55.3	43.9	66.2	45.4
Fed separately (bunk, milk parlor, etc.)	16.9	13.2	16.8	26.5	17.4
Top dressed	15.4	20.5	16.3	17.7	15.7
Other	4.8	5.8	4.9	5.9	3.9
Are feed ingredients weighed by?:	**Cow Calf %**	**Feedlot %**	**Average Beef Producers %**	**Milk Herd %**	**Overall Avearge %**
Scale	42.7	51.1	44.7	82.4	47.6
Estimated by bucket, scoop shovel, etc.	35.6	31.1	34.7	22.1	32.9
Volume	22.6	23.2	22.5	4.4	20.5
Other	1.2	1.6	1.4	2.9	1.7

Primary Feed Ingredients (Basal)

The survey instrument included a question related to the basal feed ingredients used by surveyed beef and dairy operations. Current use of feed ingredients was categorized according to the participants' type of operation, cow-calf and feedlot (beef producers) and milk herd (dairy producers). The list of feed ingredients was preset as demonstrated in the survey, and results are shown in Table 4. Corn is the predominant feed among all cattle producers, followed by mixed and grass hay among beef producers and by alfalfa and mixed hay in the dairy operations. Corn silage (90%) and haylage (59%) appear to be used as a forage resource more commonly in dairy operations compared to beef feedlots (43%, 25%) and cow calf operations (25%, 16%). Low quality forages, such as straw and corn stalks, collectively appear to be available to about 50% of all operations surveyed. Of the corn coproduct feeds, producers perceive that dry distiller's grains are more available as a primary feed ingredient across the state, followed by dry corn gluten feed, wet corn gluten feed, and wet distiller's grains. Dairy herds seem to have more access to dry distiller's grains (40%), followed by beef feedlots (16%) and cow calf producers (9%).

Table 4.
Primary Feed Ingredients (Basal)

Producers	**Beef Producers**			**Dairy Producers**	**Beef and Dairy Producers Overall Average%**
	Cow Calf %	**Feedlot %**	**Average Beef Producers %**	**Milk Herd %**	
Corn	80.4	87.4	81.3	94.1	81.9
Mixed hay	76.3	74.2	73.4	42.7	69.3

Grass hay	61.1	63.2	59.9	38.2	57.4
Alfalfa hay	50.2	55.3	48.8	75.0	51.4
Commercial protein	41.3	52.6	42.8	58.8	44.0
Soybean meal	30.3	35.8	31.7	76.5	35.7
Corn silage	25.2	43.2	29.8	89.7	35.3
Straw	24.6	30.5	24.4	36.8	24.9
Corn stalks	26.4	30.5	25.8	14.7	23.7
Haylage	16.3	24.7	18.4	58.8	22.0
Dry distiller's grains	9.2	15.8	10.6	39.7	12.8
Dry corn gluten feed	10.1	9.0	9.8	16.2	10.6
Wet corn gluten feed	5.9	9.5	6.8	13.2	7.0
Wet distiller's grains	3.9	7.4	4.6	7.4	4.6

Current Use of Biofuels Coproducts

To evaluate the past use of coproducts as a primary feed source, a question was posed listing a variety of coproducts. The participants could check all the options applicable to their operations. To explore the adoption of these types of feeds and the major limitations for the producers who use them, the participants were asked to review a variety of alternatives. These questions and responses are displayed in Table 5.

Corn gluten feeds and distiller's grains seem to have a higher adoption for use among dairy producers, with an adoption rate of 46 % and 54%, respectively. The adoption of corn coproduct useage among beef operations seem to be lower (15 to 27%). However, when compared to the other coproducts feeding alternatives, corn gluten feed and distiller's grains have higher usage. Soybean hulls appear to be the third highest option among the coproduct feed alternatives for both beef and dairy producers. Approximately 75% of all operations surveyed indicated that they have considered feeding at least one of the coproducts. The most common reasons for not considering coproducts as a feed resource were perceived limitations associated with size of the operation, availability of storage facilities and availability of equipment to handle and process feeds. Less than eight percent of all operations expressed concern about product quality/consistency.

Table 5.
Traditional and Coproducts Feeds

Have you ever fed coproduct feeds?:	**Beef Producers**			**Dairy Producers**	**Beef and Dairy Producers Overall**

	Cow Calf % (n=337)	**Feedlot % (n=190)**	**Average Beef Producers %**	**Milk Herd % (n=68)**	**Average%**
Gluten feeds	17.51	21.05	18.7	45.59	22.2
Distiller's grains	14.84	27.37	17.9	54.41	20.8
Soybean hulls	16.62	22.11	18.2	42.65	20.0
Brewer's grains	5.64	10	7.6	16.18	7.7
Bakery	4.15	6.84	4.9	8.82	5.1
Starch coproducts	2.08	5.79	3.3	7.35	3.4
Potato	0.89	3.16	1.6	1.47	1.4
Other coproducts	4.15	4.74	4.6	4.41	3.6
Have you ever considered feeding one of these coproducts?:	Beef Producers			Dairy Producers	Beef and Dairy Producers Overall Average%
	Cow Calf % (n=337)	Feedlot % (n=190)	Average Beef Producers %	Milk Herd % (n=68)	
Yes	74.8	79.3	74.9	93.3	76.8
No	25.2	20.7	25.1	6.7	23.2
If not, why not?:					
Size of operation	23.2	21.1	23.0	11.7	21.5
Storage facility	17.8	19.5	18.7	20.6	18.8
Equipment (handling, processing)	16.9	16.3	16.5	13.2	15.9
Cost	6.8	6.3	7.1	5.9	6.5
Product quality/consistency	5.0	4.7	5.4	7.4	5.6
Other	6.8	6.8	6.2	2.9	5.1

Analysis of Ethanol Plant Locations and Producers Willingness to use Biofuel Coproducts

The survey format allowed an evaluation of producer proximity to one or more ethanol plants. When analyzing the location of the survey participant operations and their consideration to feed biofuel coproducts, the results indicate that for operations within counties with ethanol plants, 70% have considered using distiller's grains. For the operations within counties that border a county with an ethanol plant, the number of operations that have considered using distiller's grains

increased to 76%. Interestingly, for producers in a county that did not border a county with an ethanol plant, 79% of the operations have considered feeding biofuel coproducts to their livestock. These results suggest a willingness among cattle producers to integrate alternative feed ingredients into their operations. Further study may be justified to provide a detailed analysis of the availability of biofuel coproducts to producers.

Discussion: Opportunities and Limitations for Biofuel Coproducts

Based on nutrient composition, DDGS are considered a good source of energy and protein in cattle diets and have effectively replaced corn grain and protein supplementation in finishing rations. In fact, when fed at levels to supply adequate protein and energy, replacing a portion of corn with DDGS has resulted in equal and sometimes greater performance of cattle. Gordon et al. (2002) reported increased intake, average daily gain, and feed efficiency in heifers fed finishing diets with inclusion of DDGS at 50% of the diet. The likely mechanism behind increased performance is due to the digestibility of the feed. Pingel and Trenkle (2006) reported that the digestibility of distiller grains had a higher feed value than corn when included at 20% of the diet. Additionally, the greater performance is likely due to increased fiber digestion.

There is a negative correlation between starch content and fiber digestion. Corn grains have relatively high starch content, while DDGS has had most, or all of the starch removed. This leaves a very fermentable structural carbohydrate source that will have a positive associative affect on fiber digestion, providing more stability in rumen pH and decreasing the probability of sub-clinical or clinical acidosis. However, increasing the DDGS fraction of the diet also has resulted in decreased starch digestibility (Pingel & Trenkle, 2006). Although this apparently does not affect feedlot performance, the effects on carcass composition have yet to be elucidated.

In the Eastern Corn Belt, beef and dairy operations are typically small to medium-sized. Results from the survey indicate that most Indiana beef and dairy producers use traditional feedstuffs, such as corn and soybean meal, while few are currently using coproducts. With the challenge of growing competition for corn in both local and international markets, beef and dairy producers are looking for alternative feed resources. Biofuel coproducts offer small to medium-sized beef and dairy producers an alternative feed resource that is high in both energy and protein. These products are offered into the marketplace in both wet and dry forms; however, the most inexpensive form of nutrients are typically in the wet form (Weiss, Eastridge, Shoemaker, & St-Pierre, 2010).

The corn coproducts (distiller's grains and corn gluten feed), in particular, create some nutritional and management challenges when fed at high dietary inclusion rates. The challenges arise when excess protein (N), fat, sulfur and/or phosphorus are delivered to the animal. Individually, and collectively, these nutritional factors will limit the dietary inclusion level for any given class of animal. An abundant amount of research has been published on the use of corn coproducts in total mixed rations for beef feedlot cattle and dairy rations. In general, nutritionists in the industry have used corn coproducts as a source of dietary protein to help meet animal requirements, but not as a primary replacement of dietary energy. When corn coproducts are used as a primary energy source in the diet, the challenges associated with overfeeding protein (N), fat, sulfur, and phosphorus can impact animal performance, end-product quality, and nutrient levels in the manure.

For example, in lactating dairy cow diets, the first limiting factor in most cases is dietary fat. Most nutritionists recommend limiting distiller's grains to less than 15% of the ration dry matter to minimize the potential for a milk fat depression that can result from excess dietary fat. In the case of feedlot cattle, most nutritionists limit the amount of distiller's grains in rations based on dietary fat, sulfur, and nitrogen. A typical recommendation is less than 25% of the ration dry matter to minimize the impact of excess protein on marbling (carcass quality grade); excess fat on rumen fermentation, excess sulfur, which can cause polio encephalomalacia; and/or the amount of both nitrogen and phosphorus excretion in the manure. When these nutritional and management constraints are considered, in addition to the costs associated with transportation, storage, and spoilage of coproducts in small to medium-sized beef and dairy operations, these can become a deterrant to the use of coproducts.

The primary challenges of feeding coproducts, especially wet products, identified by producers in this survey fall into three main categories; transportation, storage, and potential for spoilage before feeding. The survey results indicated that the majority of the participants (75% of the beef and 84% of the dairy operations) have considered using coproducts as a source of livestock feed; however, as suggested in Table 5, a relatively small percentage of producers surveyed have used coproducts. This suggests that there is opportunity and potential to increase the use of ethanol coproducts in the beef and dairy industries if effective, efficient, and profitable strategies can be developed to address these challenges. Furthermore, results from Table 3 would suggest that the majority of producers surveyed have the feed resources available to use coproducts feeds on a daily basis. However, research on how small and medium-sized producers can effectively store and use loads of coproducts must be addressed before they become a viable option for most Indiana producers.

The most economical and practical mode of transporting coproducts is by semi-load quantities. The logistics and costs associated with transporting, storing and feeding semi-load quantities in a timely manner was perceived to be a challenge for small to medium-sized producers, and results from this survey seem to support that hypothesis. Distance from a processing plant and the associated cost was also perceived to be a factor for both beef and dairy operations. However, analysis of the survey data indicated that within the state, location of the ethanol plants compared to location of the survey participant operations did not represent a deterrent to the interest in the use of biofuel coproducts as a feed resource.

Small and medium-sized operations have limited ability to use large quantities of coproducts, especially perishable wet coproducts, due to their short shelf life, limitations in dietary inclusion rates due to nutritional restrictions, as well as availability of on-farm resources (storage and handling equipment). Beef and dairy operations are interested in using biofuel coproducts if a simple and economical transportation, storage, and feeding strategy can be developed. Additional research and information dissemination are needed to address these producer issues before a higher level of adoption can be realized.

In summary, biofuel coproducts have the potential to make small and medium-sized beef and dairy operations much more competitive by reducing feeding costs (Lemenager, Applegate, Claeys, Donkin, Johnson, Lake S., et al., 2006). To encourage the adoption of coproducts as a feed alternative, research and educational programs must address the main concerns and limitations identified by cattle producers. Strategies that minimize the need for adding expensive equipment and storage facilities and the reduction in spoilage losses would significantly reduce the limitations of adopting biofuel coproducts identified by small and medium-sized beef and dairy operations.

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