Could Co-products Give Corn and Soybean Meal a Run for Your Money?

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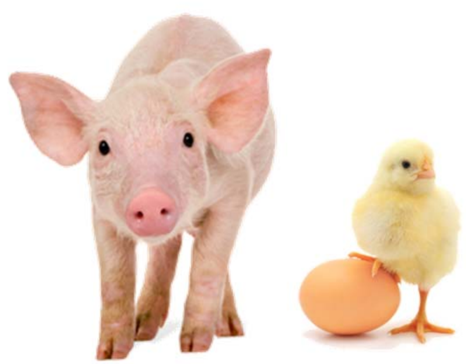
Monogastric Feed Research Group

Our mission:

To enhance the feed competitiveness of pig and poultry production in Alberta (and ~~Western~~ Canada in general)



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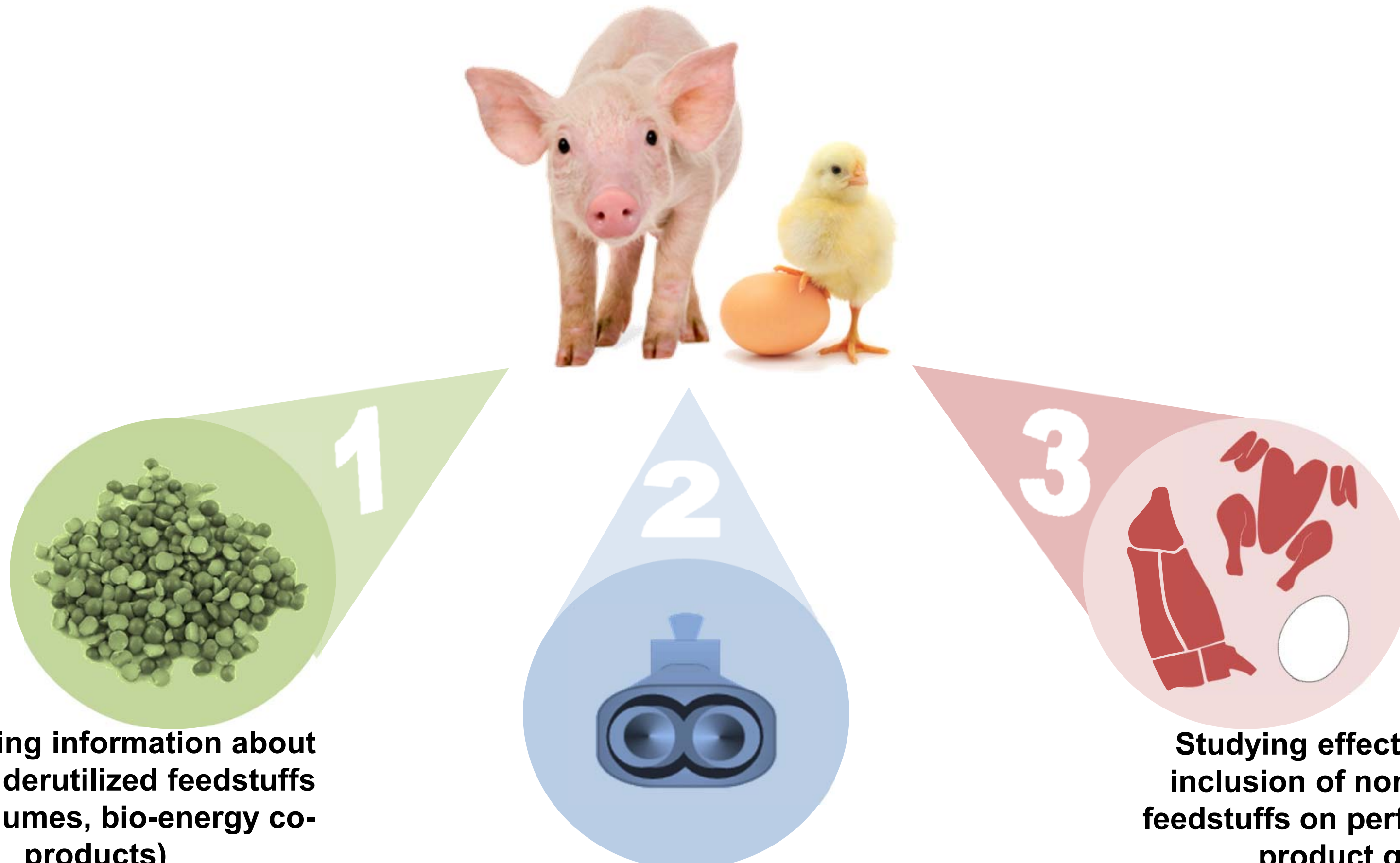
Our Approach



Developing information about novel/underutilized feedstuffs (e.g., legumes, bio-energy co-products)

Studying cost effective processing methods to improve nutritive value of non-traditional feedstuffs

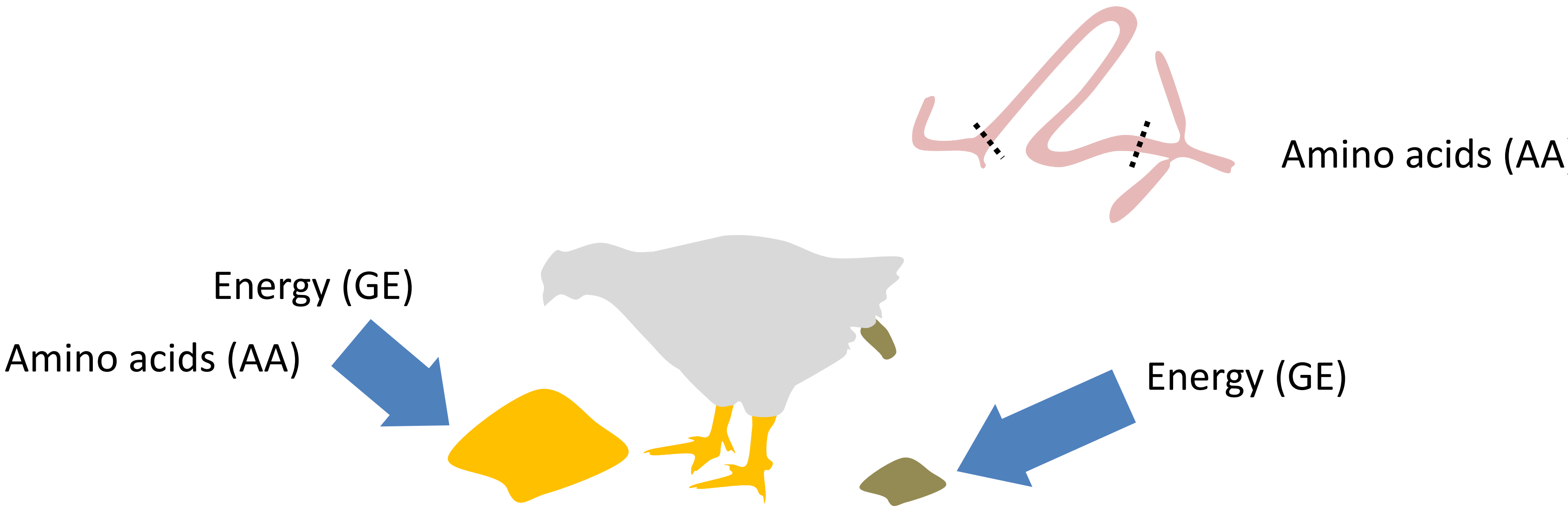
Studying effects of dietary inclusion of non-traditional feedstuffs on performance and product quality


Faba beans
Corn DDGS
Field peas
Wheat DDGS
Lentils
Canola meal
Lupin
Camelina meal

Why I'm here (….I think)

Feedstuffs	Truro, NS	Edmonton, AB	% Diff
Wheat	350	288	- 18%
Oats	-	188	???
Barley	399	255	- 36%
Corn	323	316	- 2%
Soybean Meal 48%	538	455	- 15%
Canola Meal	441	315	- 29%
Corn DDGS	360	330	- 8%
Eggs (farm price, $/doz.)	**NS**	**AB**	
Grade A (Jumbo, XL, L)	2.13	2.13	-
Broilers (farm price, $/kg live wt)	**NS**	**AB**	
1.4 - 2.7 kg (live) average	1.82	1.74	- 5%

Important concepts…
(just so we're all on the same page)

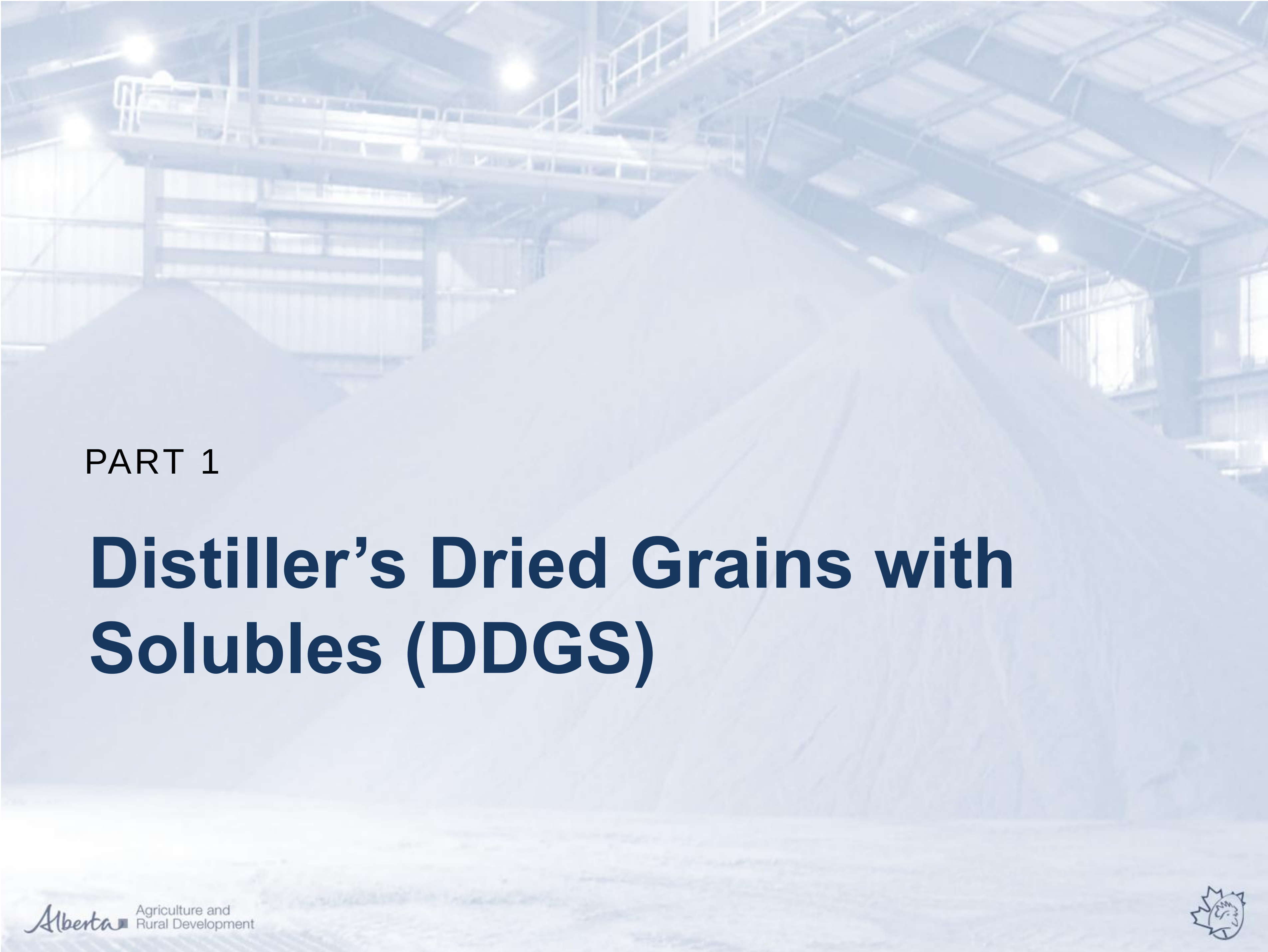


Gross $\text{Energy}_{\text{feed}}$ – Gross $\text{Energy}_{\text{excreta}}$ = Apparent Metabolizable Energy (AME)

Digestible AA = % of AA digested and absorbed by the end of the small intestine

My ‘to-do’ list for today

1. **Brief overview of what the research (including ours) says about DDGS and canola meal**
2. **Challenges associated with co-product use (and what to do about them)**
3. **Recommendations on how to optimize use of co-products in poultry feeds**



PART 1

Distiller’s Dried Grains with Solubles (DDGS)

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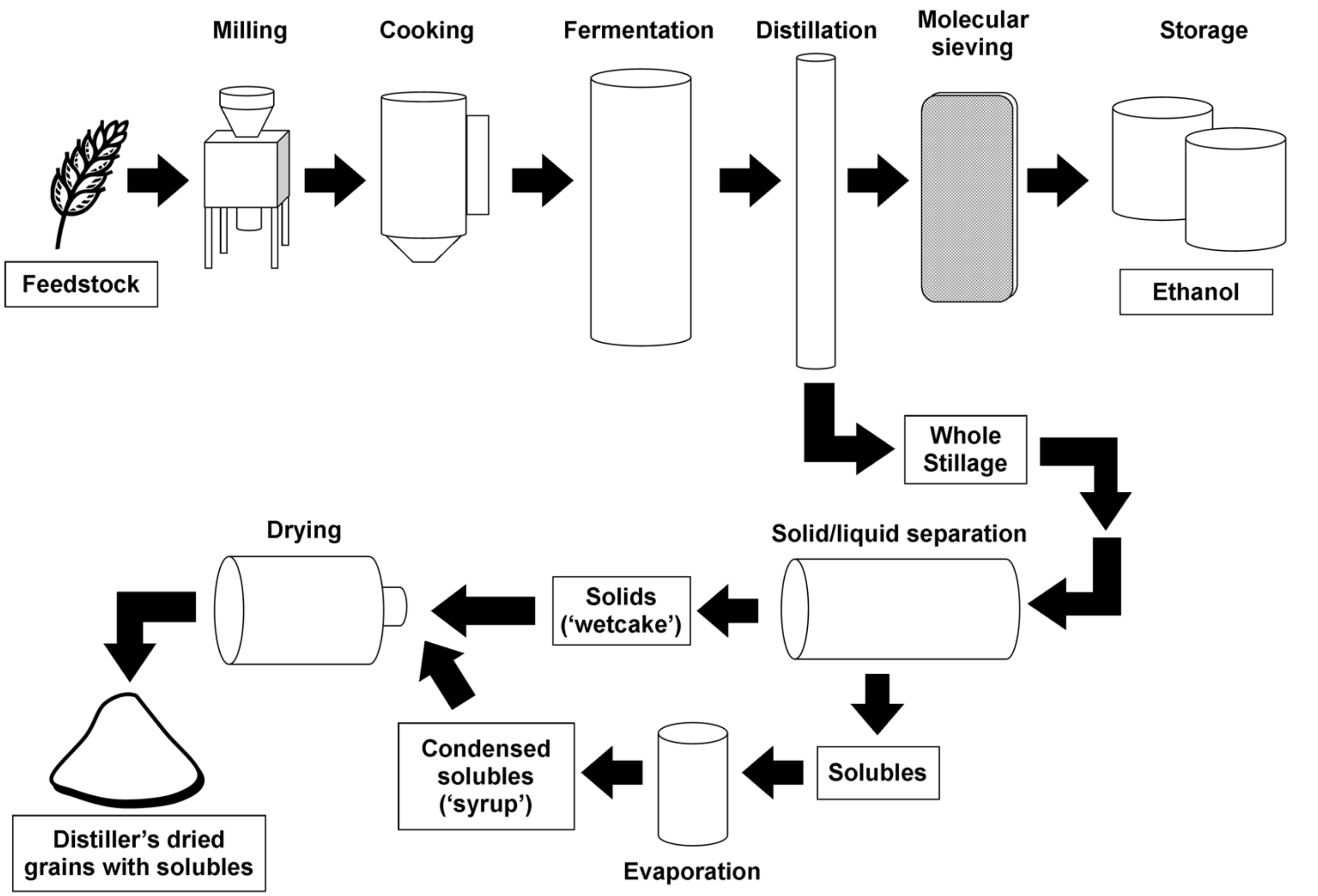
Figure 1. Grain-based ethanol-DDGS production flow chart



Adapted from Renewable Fuels Association

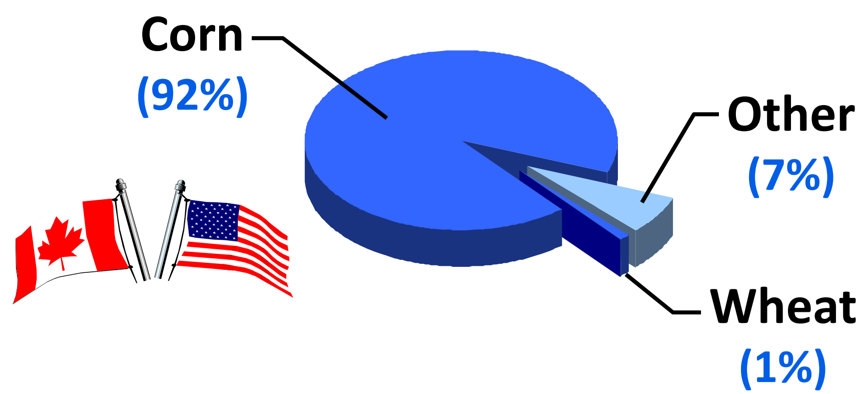
DDGS for Poultry:
What the literature says…

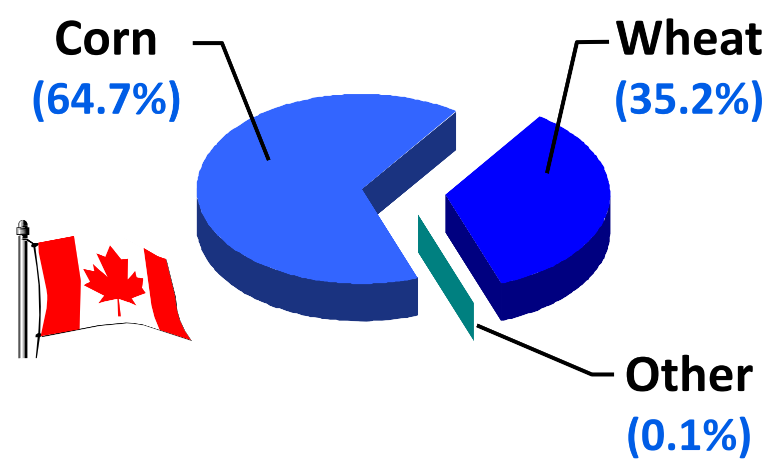
- **100+ citations in the literature for corn DDGS**
  - The most studied ingredient in the last 10 years
- **Widely included in commercial US poultry rations (depending on availability)**
  - Broilers → 5 – 15%
  - Layers → 5 – 10%
  - Turkeys → 5 – 15%

DDGS for Poultry:
What the literature says…

- ▲oil content = ▲ energy concentration
- Lighter colour = ▲ AA digestibility
- P and minerals are highly available (thank you yeast!!!)
- Wide variation in nutrient content between plants and regions
  - Greater quality control → consistency within plant
  - More on this later…

Ethanol Production in NA & Canada





DDGS for Poultry:

What our research says…

- **AA digestibility coefficients in wheat and corn DDGS are similar**
- **Corn, wheat and triticale DDGS all respond positively to extrusion treatment**
- **Dry fractionation increases digestible nutrient density but not digestibility**
- **No negative effects of up to 10% inclusion of corn, wheat or triticale DDGS in wheat-based broiler diets**

Formulation matrix values for wheat and corn DDGS

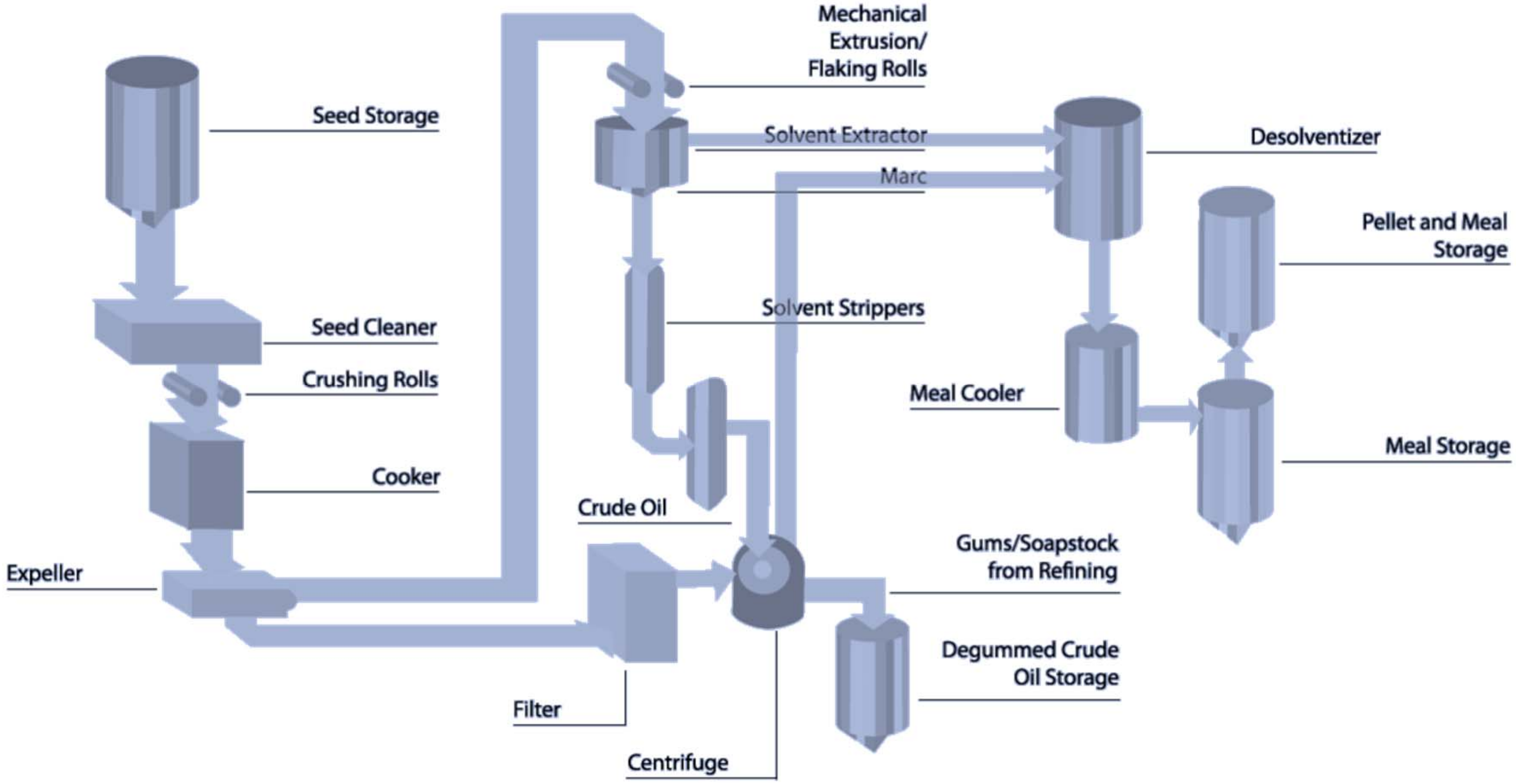
Nutrient	New Generation Corn DDGS	New Generation Wheat DDGS
AME, kcal/kg	2.94	2.22
Crude Fat	10.08	4.06
Crude Protein	26.45	39.40
Calcium	0.07	0.13
Av. phosphorus	0.48	0.44
AID Arginine	0.93	1.31
AID Lysine	0.50	0.60
AID Methionine	0.43	0.47
AID Total Sulfur AA	0.85	1.41
AID Threonine	0.72	0.35
AID Tryptophan	0.18	1.02

PART 2

CANOLA MEAL

Location of crushing plants in Canada

Overview of Canola Crushing



from Canola Meal Feed Industry Guide

Feeding value of ‘modern’ canola meal

- **The Canola Science Cluster (AAFC)**
  - Joint initiative that is industry-lead and supported by federal research funding
  - Intent: to mobilize scientific/technical resources to support innovation and competitiveness in canola sector
- **Includes meal nutrition theme**
  - Mission: increase AME content in canola meal by 10%

Entry Number	Feed Name Description	International Feed Number[a]	Dry Matter (%)	ME_n (kcal/kg)
	Alfalfa *Medicago sativa*			
01	meal dehydrated, 17% protein	1-00-023	92	1,200
02	meal dehydrated, 20% protein	1-00-024	92	1,630
03	Bakery			
	waste, dehydrated (dried bakery product)	4-00-466	92	3,862
	Barley *Hordeum vulgare*			
04	grain	4-00-549	89	2,640
05	grain, Pacific coast	4-07-939	89	2,620
	Broadbean *Vicia faba*			
06	seeds	5-09-262	87	2,431
	Blood			
07	meal, vat dried	5-00-380	94	2,830
08	meal, spray or ring dried	5-00-381	93	3,420
	Brewer's Grains			
09	dehydrated	5-02-141	92	2,080
	Buckwheat, common *Fagopyrum sagittatum*			
10	grain	4-00-994	88	2,660
	Cane Molasses—see Molasses			
	Canola *Brassica napus-Brassica campestris*			
11	seeds, meal prepressed solvent extracted, low erucic acid, low glucosinolates	5-06-145	93	2,000

from NRC, 1994

Digestible nutrient matrix for various canola meal types studied in our lab

	B. napus			*B. juncea*
	SE	**EP**	**EXT-EP**	**SE**
AME, kcal/kg	2518	2699	3192	2658
Crude fat, %	1.91	12.75	17.12	1.72
Crude fibre, %	7.24	6.01	10.04	8.05
Dig Crude protein, %	28.37	24.47	23.45	29.73
Dig Total AA, %	27.23	24.36	20.30	26.77
Dig Lysine, %	1.56	1.53	1.17	1.52
Dig Methionine, %	0.64	0.56	0.49	0.65
Dig Met + Cys, %	1.21	1.17	1.05	1.31
Dig Threonine, %	1.17	1.03	1.00	1.17
Dig Tryptophan, %	0.35	0.44	0.35	0.37

Performance of broilers fed diets containing graded inclusion levels of *B. napus* or *B. juncea* meal (d0 - 35)

	Dietary inclusion level of CM, %							
		B. napus			*B. juncea*			
	0%	**10%**	**20%**	**30%**	**10%**	**20%**	**30%**	***Stats***
Wt, d 35	2284	2236	2282	2269	2300	2312	2261	NS
ADG	61.9	60.7	62.0	61.7	62.5	62.9	61.4	NS
ADFI	106.8	107.1	106.7	107.3	107.5	107.9	108.4	NS
GF	0.614	0.607	0.625	0.616	0.621	0.614	0.606	NS
Carcass Wt, g	1518	1511	1514	1502	1512	1504	1499	NS
Dressing, %	0.697	0.694	0.695	0.690	0.694	0.689	0.687	NS
Net revenue, ($/ bird marketed)	**2.73^{bc}**	**2.66^{d}**	**2.74^{bc}**	**2.70^{cd}**	**2.80^{ab}**	**2.86^{a}**	**2.74^{bcd}**	***

PART 2

Challenges associated with use of co-products

Things to worry about when using co-products…(and what to do)

- **Bin space requirements**
- **Pellet quality**
- **Variability**
- **Energy density**

Bin space

- **Increasing co-product inclusion tends to reduce bulk density of the diet**
  - Need more bin space per T of feed
  - Much more serious issue at feed mills

Bin space

	Corn-SBM	Corn-SBM-15% Corn DDGS	Corn-SBM-15% Canola meal
Corn	57.77	49.75	53.42
Soybean meal	35.27	28.53	23.93
Corn DDGS	-	15.00	-
Canola meal	-	-	15.00
Bulk density (kg/m^3)	664	641	633
Space requirements (m^3/T)	1.51	1.56	1.58

Bin space

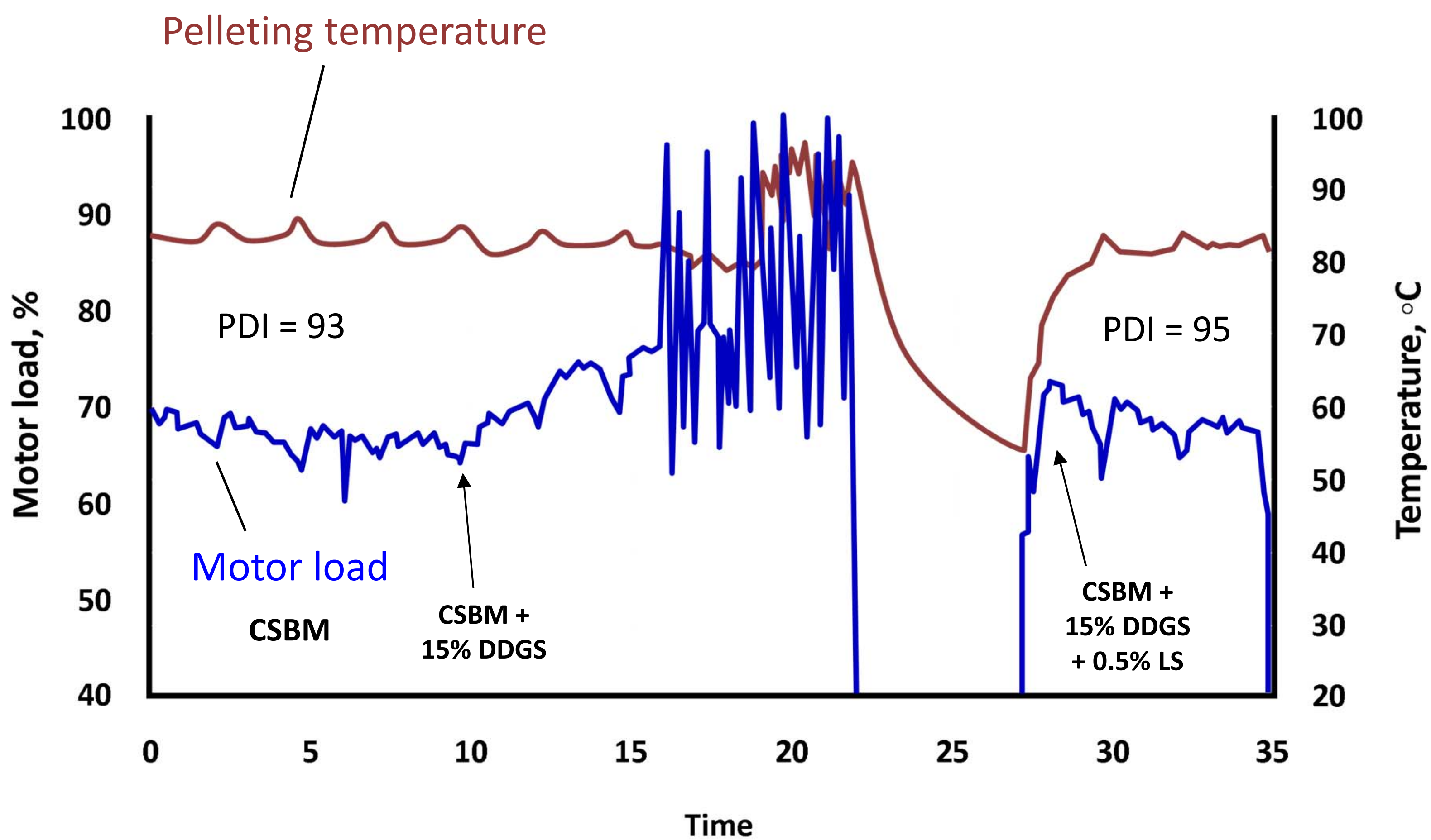
		Unprocessed Corn DDGS			Pelleted-Reground Corn DDGS		
	Control	10%	20%	30%	10%	20%	30%
Mash BD (kg/m^3)	57.99^{a}	56.6^{bc}	54.73^{d}	53.22^{e}	57.14^{ab}	55.56^{cd}	54.98^{d}
Pellet BD (kg/m^3)	62.43^{a}	60.71^{bc}	58.66^{de}	57.87^{e}	61.77^{ab}	60.15^{bcd}	59.84^{cd}

from Farenholz, 2005

Pellet quality

- **Limited info on effects of canola meal but problems with DDGS are well documented**
  - Low-starch, high oil in DDGS interferes with bonding
  - Less Dical required in co-product diets (‘polishes’ die)
- **Fibre content/type is problematic**
  - Fibre doesn’t compress easily
  - Pelleter has to operate at higher power to push co-product containing mixtures through

Pellet quality case study



From Lignotechfeed.com

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Optimizing pellet quality when feeding co-products

- **Proper conditioning helps**
  - Target for 15-16% moisture going into the pelleting chamber
- **Pellet binders seem to make a big difference**
  - Improves pellet durability and reduces load on the pelleter
  - Lignosulfonate (by-product of paper processing) seems to be effective with DDGS formulations

Variability in co-product feed quality

- **Not really a big issue with modern solvent-extracted canola meal**
- **Big issue with corn DDGS**
  - Particularly with move toward fractionation prior to fermentation (variable oil and fibre content)
  - Has big effect on AME content and therefore relative economic value

Variability in DDGS feed quality

Origin	VeraSun Energy Corporation (Aurora, SD)	VeraSun Energy Corporation (Aurora, SD)	Ace Ethanol (Racine, WI)	Poet Biorefining (Groton, SD)	Poet Biorefining (Corning, IA)	Hawkeye Renewables (Iowa Falls, IA)
Bulk density (kg/m³)	490	490	580	470	440	470
Avg Particle size (µm)	579	480	1054	330	352	784
Moisture	13.41	12.64	6.82	10.87	8.20	9.75
Gross energy (kcal/kg)	5434	5076	5314	5547	5174	5375
Crude protein	31.94	34.74	29.62	29.49	26.48	29.65
Starch	6.24	3.04	7.85	4.94	3.30	3.47
NDF	40.12	50.96	34.61	33.41	27.72	40.13
Crude fat	10.16	3.15	11.45	11.71	11.52	10.89
AMEn, kcal/kg	2685	2146	2628	3098	2903	2593
Relative value	0.87	0.69	0.85	100	0.94	0.84

AMEn, kcal/kg of DM = −30.19(NDF,% DM) + 0.81(GE, kcal/kg) − 12.26 (CP, % DM) $\boldsymbol{R^2 = 0.87}$

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Coping with variability

- **Contracted levels with supplier**
  - Guaranteed min. fat and protein
  - Guaranteed max. moisture and fibre
- **Wet chem testing random samples from random batches to ensure levels are being met**
  - Penalty to supplier for non-compliance
  - When coupled to NIRS technology saves big $$$ over long term (Alberta's strategy)

Dietary energy density

- **Breeding company recommendations suggest high nutrient density (e.g., C-SBM)**
  - Performance = Genetics + Environment + G x E
  - E.g., recommended AME content for broilers is 3.05, 3.15 and 3.2 Mcal/kg in starter, grower and finisher phases, respectively
- **To achieve these densities, usually there is reliance on fat in the diet**
  - Fat is the most expensive macroingredient in a feed (>$1000/T)

Dietary energy density

- **The key to optimizing use of co-products in poultry feeds actually lies in:**
  - Formulating diets on a digestible nutrient basis
  - Formulating to lower energy density
- **Ignore Feed Efficiency/Feed Conversion**
  - Focus more on income over feed cost
  - Birds are biologically capable of compensating for lower energy density by increasing feed intake

Feed cost scenario exercises

- **Conservative approach**
  - Finisher phase only
  - Co-product inclusion capped at 15% max.
- **Assumptions:**
  - CFC production stats for NS, NB and PEI in 2012
  - 55% of market weight gained during finisher period
  - 5 Mcal/kg of liveweight gain (> 14 d of age)
  - Ingredient costs = actual feed costs in Truro in mid Jan
  - $30/T margin added to all formula costs

Scenario 1: The effect of lowering target AME density in finisher phase (d 25-market) using exclusively corn-SBM formulation

	Target AME density in finisher formula, Mcal AME/kg				
Ingredient, % of formula	**3.20**	**3.15**	**3.10**	**3.05**	**3.00**
Corn	55.4	56.58	57.77	58.96	60.14
Soybean meal	35.68	35.48	35.27	35.07	34.86
Canola oil	4.72	3.8	2.88	1.96	1.05
Methionine	0.28	0.27	0.27	0.27	0.26
Limestone	1.27	1.24	1.22	1.19	1.16
Dical	1.16	1.12	1.09	1.06	1.03
Other stuff	1.5	1.5	1.5	1.5	1.5
Feed cost, $/Tonne	485.16	477.34	469.52	461.70	453.88
Feed Conversion, kg feed: kg gain	1.563	1.587	1.613	1.639	1.667
Cost of gain, $/kg liveweight	0.758	0.758	0.757	0.757	0.756
Estimated Feed Cost, $/producer/yr					
New Brunswick	$406,319	$406,117	$405,908	$405,693	$405,470
Nova Scotia	$214,531	$214,424	$214,314	$214,200	$214,082
PEI	$241,063	$240,943	$240,819	$240,691	$240,559
Net Savings, $/producer/yr					
New Brunswick	0	$202.33	$411.10	$626.72	$849.53
Nova Scotia	0	$106.83	$217.06	$330.90	$448.54
PEI	0	$120.04	$243.90	$371.82	$504.01

Scenario 2: The effect of lowering target AME density in finisher phase (d 25-market) using corn-SBM formulations allowing up to 15% corn DDGS inclusion

	Target formula AME, Mcal/kg					
Ingredient, % of formula	**3.20 CSBM**	**3.20**	**3.15**	**3.10**	**3.05**	**3.00**
Corn	55.40	47.40	48.57	49.75	50.92	52.10
Soybean Meal	35.68	28.84	28.69	28.53	28.38	28.17
Corn DDGS	-	15.00	15.00	15.00	15.00	15.00
Canola Oil	4.72	4.74	3.82	2.89	1.96	1.04
Limestone	1.27	1.41	1.38	1.35	1.33	1.30
Dical	1.16	0.95	0.92	0.89	0.85	0.82
Lysine	-	0.05	0.03	0.02	-	-
Methionine	0.28	0.18	0.17	0.15	0.14	0.14
Other	1.50	1.42	1.42	1.42	1.42	1.42
Feed Cost, $/Tonne	$485.16	$471.27	$462.42	$453.57	$444.73	$436.91
FCR, kg feed:kg gain	1.563	1.563	1.587	1.613	1.639	1.667
Feed cost, $/kg liveweight gain	$0.758	$0.736	$0.734	$0.732	$0.729	$0.728
Estimated feed cost, $/producer/yr						
New Brunswick	$406,319	$394,691	$393,425	$392,118	$390,782	$390,308
Nova Scotia	$214,531	$208,391	$207,723	$207,033	$206,327	$206,077
PEI	$241,063	$234,164	$233,413	$232,637	$231,844	$231,563
Net savings, $/producer/yr						
New Brunswick		$11,628	$12,894	$14,201	$15,538	$16,011
Nova Scotia		$6,140	$6,808	$7,498	$8,204	$8,454
PEI		$6,899	$7,650	$8,425	$9,218	$9,499

Scenario 3: The effect of lowering target AME density in finisher phase (d 25-market) using corn-SBM formulations allowing up to 15% canola meal inclusion

	Target formula AME, Mcal/kg					
Ingredient, % of formula	**3.20 CSBM**	**3.20**	**3.15**	**3.10**	**3.05**	**3.00**
Corn	55.40	54.25	52.52	53.42	54.61	55.79
Soybean Meal	35.68	32.66	24.88	23.93	23.72	23.52
Canola Meal		4.00	14.01	15.00	15.00	15.00
Canola Oil	4.72	5.00	4.79	3.94	3.02	2.11
Limestone	1.27	1.24	1.13	1.10	1.07	1.04
Dical	1.16	1.13	1.05	1.01	0.98	0.95
Methionine	0.28	0.25	0.17	0.16	0.15	0.15
Other	1.50	1.48	1.45	1.44	1.44	1.44
Feed Cost, $/Tonne	$485.16	$483.75	$472.68	$464.54	$456.72	$448.90
FCR, kg feed:kg gain	1.563	1.563	1.587	1.613	1.639	1.667
Feed cost, $/kg liveweight gain	$0.758	$0.756	$0.750	$0.749	$0.749	$0.748
Estimated Feed Cost, $/producer/yr						
New Brunswick	$406,319	$405,141	$402,152	$401,604	$401,316	$401,018
Nova Scotia	$214,531	$213,908	$212,330	$212,041	$211,889	$211,731
PEI	$241,063	$240,363	$238,590	$238,265	$238,094	$237,917
Net Savings, $/producer/yr						
New Brunswick		$1,179	$4,168	$4,715	$5,003	$5,301
Nova Scotia		$622	$2,201	$2,489	$2,642	$2,799
PEI		$699	$2,473	$2,797	$2,968	$3,145

Summary of cost exercises

Annual finisher phase feed cost savings, $/average producer/yr

	Target AME, Mcal/kg				
Province/scenario	**3.20**	**3.15**	**3.10**	**3.05**	**3.00**
New Brunswick					
Corn-SBM	-	$202	$411	$627	$850
Corn-SBM-15% max DDGS	$11,628	$12,894	$14,201	$15,538	$16,011
Corn-SBM-15% max CM	$1,179	$4,168	$4,715	$5,003	$5,301
Nova Scotia					
Corn-SBM	-	$107	$217	$331	$449
Corn-SBM-15% max DDGS	$6,140	$6,808	$7,498	$8,204	$8,454
Corn-SBM-15% max CM	$622	$2,201	$2,489	$2,642	$2,799
PEI					
Corn-SBM	-	$120	$244	$372	$504
Corn-SBM-15% max DDGS	$6,899	$7,650	$8,425	$9,218	$9,499
Corn-SBM-15% max CM	$699	$2,473	$2,797	$2,968	$3,145

Are there risks to reducing AME density in diets?

- **Genetically, modern poultry lines have the ability to adjust intake based on energy density**
  - Practical constraining factors are environmental
- **Expect negative impacts on performance if birds are overcrowded**
  - If dropping energy density in diets, stay towards lower end of CFC recommended density guidelines (31 kg/m^2)
  - Gap in the literature: importance of feeder space at different stocking densities

Take-away messages

- **Co-products have come a long way**
  - Modern stocks are greatly improved thanks to better QC by producers
- **Both DDGS and CM are high quality feeds for poultry backed up by considerable research**
  - Corn DDGS = proportionately displaces corn and SBM
  - Canola meal = displaces SBM only

Take-away messages

- **There are challenges to using co-products but these are for the most part manageable**
  - Variability in DDGS feed quality is of principal concern
- **Big opportunity for cost savings**
  - Savings will depend on prices of DDGS, canola meal in relation to corn/SBM
  - Dropping energy density in diets is key to optimizing cost savings

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