Hybrid rye replacing wheat grain for hogs

Miranda N. Smit, Xun Zhou, José L. Landero,
Malachy G. Young, and Eduardo Beltranena

Alberta
Agriculture
and Forestry

Gowans
FEED CONSULTING

Monogastric Feed Research Group

- What we do:
  - Feed research trials in pigs and poultry focusing on novel or underutilized ingredients, their fractions and co-products, and processing methods
- Why we do it:
  - Reduce feed costs for producers
  - Research feeding value of locally grown ingredients to reduce reliance on imported ingredients
  - Create a local market for surplus inventories
  - Decrease the carbon footprint of pork or poultry products through feeding strategies

Why rye?

- ~324,000h sown to rye in Canada, ~80% in Prairies.
- Rye is a cereal crop similar to wheat.
- Rye in Canada is used mostly for whiskey and spirits.
- Hardiness allows for efficient use of spring runoff.
- Extends the ‘work season’ vs. spring planted cereals.

Why not rye?

- Historically, conventional rye not fed to pigs due to high occurrence of ergot
- Ergot alkaloids are anti-nutritional factors depressing growth performance

Why hybrid rye?

- Hybrids produce vast amounts of pollen. Stigma is oversaturated by pollen. Mold spores have a lesser chance to infect plant.
- Fall planted rye flowers earlier than spring sown cereals. Ergot and fusarium infection risk is lower. Plants are less stressed in spring vs. summer.
- Novel European hybrids yield >30% more over conventional rye, 20-40% over wheat grain.
- **Greater grain yield compared with wheat** was an attractive incentive for us to evaluate feeding hybrid fall rye to hogs.

Fibre in rye grain

- Rye has greater fibre content than wheat grain.
- Fibre in rye grain is mostly complex gummy sugars.
- These soluble sugars could be made more digestible/fermentable by feeding NSP enzymes.
- Prairie hog producers typically stock two cereal grains (barley, wheat), but not 3, so we decided to…

✓Evaluate feeding increasing hybrid rye inclusions replacing wheat grain.

✓Test whether or not NSP enzymes would make hybrid rye grain more digestible.

%	Rye	Wheat
Total NSP	13.1	9.8
Arabinose	2.8	2.1
Xylose	4.6	3.5
Glucose	4.8	3.5
Uronic acid	0.3	0.3

Commercial scale hog trial setup

- **Drumloche Research Barn at Lougheed, AB**

- 2 growout rooms
- 52 pens in each room
- 6 feed bins per room

Materials and Methods

- 1008 pigs
- 48 pens, 21 pigs per pen
- Housed by sex
- 4 end pens to house pigs removed
- 0.7 $m^{2/}$pig
- Started ~44 kg BW
- Wet-dry feeders
- Extra cup drinker per pen
- Feed Logic robotic weighing unit

Materials and Methods

- **Design:**
  - Randomized complete block design
  - Rye substituted wheat grain (low, medium, high)
  - 2 enzyme levels of inclusion (0 or 0.02%)
  - 2 sexes (barrows or gilts)
  - Pigs blocked by sex
  - 4 replicate pens per rye substitution level x enzyme x gender
- **Analysis:**
  - 3 x 2 x 2 factorial. Proc mixed in SAS
  - Fixed terms: rye substitution level, enzyme, sex
  - Random term: block

1		52
2	Block 1 Barrow	51
3		50
4		49
5	Block 1 Gilt	48
6		47
7		46
8	Block 2 Barrow	45
9		44
10		43
11	Block 2 Gilt	42
12		41
13		40
14	Block 3 Barrow	39
15		38
16		37
17	Block 3 Gilt	36
18		35
19		34
20	Block 4 Barrow	33
21		32
22		31
23	Block 4 Gilt	30
24		29
25		28
26		27

Materials and Methods

- **Feedstuffs:**
  - **Wheat grain:**
    - Mainly soft wheat 10-11% protein
    - Grown within 100-160 km radius of Irma, AB
  - **Rye grain:**
    - Hybrid variety Bono developed by KWS LOCHOW GMBH (Bergen, Germany)
    - Grown at Kalco Farms near Gibbons, AB
  - **Enzyme:**
    - Endofeed W DC (GNC Bioferm, Bradwell, SK)
    - Containing 1400 units/g β-glucanase
    - 4500 units/g xylanase
    - Inclusion level 200 mg/kg

Materials and Methods

- **Ingredient specs:**

Formulation

RM code	SFM004	SFM112
Name	Wheat 11% CP	Rye 9.9% CP
DM	85.40	86.40
CP	11.07	9.94
EE	1.63	1.49
ASH	1.98	1.18
NDF	9.86	13.26
ADF	3.41	3.43
STARCH TOT	57.59	57.82
NE GF	2.47	2.39
STTD P	0.12	0.09
SD LYS	0.26	0.28
SD M+C	0.36	0.31
SD THR	0.27	0.24
SD TRP	0.12	0.08

Analysed

	Wheat	Rye
	Batch average	
Starch	55.2	50.9
Crude protein	12.2	10.1
NDF	9.8	11.0
ADF	2.7	2.6
Crude fibre	2.1	1.8
Ash	1.5	1.4
Crude fat	1.9	1.8
Potassium	0.4	0.5
Phosphorus	0.3	0.3
Magnesium	0.1	0.1
Chloride	0.1	0.1
Calcium	0.0	0.0
Sodium	0.0	0.0

- NE values taken from EvaPig and the SID AA values from Evonik AminoDat 5.0

Materials and Methods

- **Diets**

	Grower 2			Grower 3			Finisher 1			Finisher 2		
	Rye inclusion			Rye inclusion			Rye inclusion			Rye inclusion		
	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
Wheat	313.1	155.7	20.0	412.1	205.1	20.0	440.7	219.3	20.0	456.5	226.8	20.0
Rye	156.6	312.0	446.0	206.0	410.3	591.4	220.3	439.0	635.8	228.2	455.0	659.2
wDDGS	287.2			217.2			234.5			240.1		
Peas	204.8			139.1			81.0			52.2		
Canola oil	13.2	15.4	17.3	4.0	6.9	10.0	4.0	7.1	9.9	4.0	7.2	10.2
L-Lys	4.70	4.67	4.65	4.0	3.96	3.94	3.50	3.46	3.43	3.20	3.16	3.12
Others	20.4	20.2	20.0	17.6	17.4	18.4	16.0	15.6	15.4	15.8	15.5	15.2
NE Mcal/kg	2.30			2.30			2.30			2.30		
SID Lys/NE	3.89			3.31			2.91			2.69		

Others: Limestone, Mono-cal, Salt, DL-Met, L-Thr, Phytase, Feeder Micro.

Materials and Methods

- **Measurements:**
  - Pen groups weighed every 2 weeks
  - Pen feed added and remaining
  - Market weight to calculate dressing %
  - **Carcass:**
    - Warm weight
    - Backfat depth
    - Loin depth
    - Estimated yield and index
  - **Cost:**
    - Income over feed cost
    - **Lean pork/unit of land**

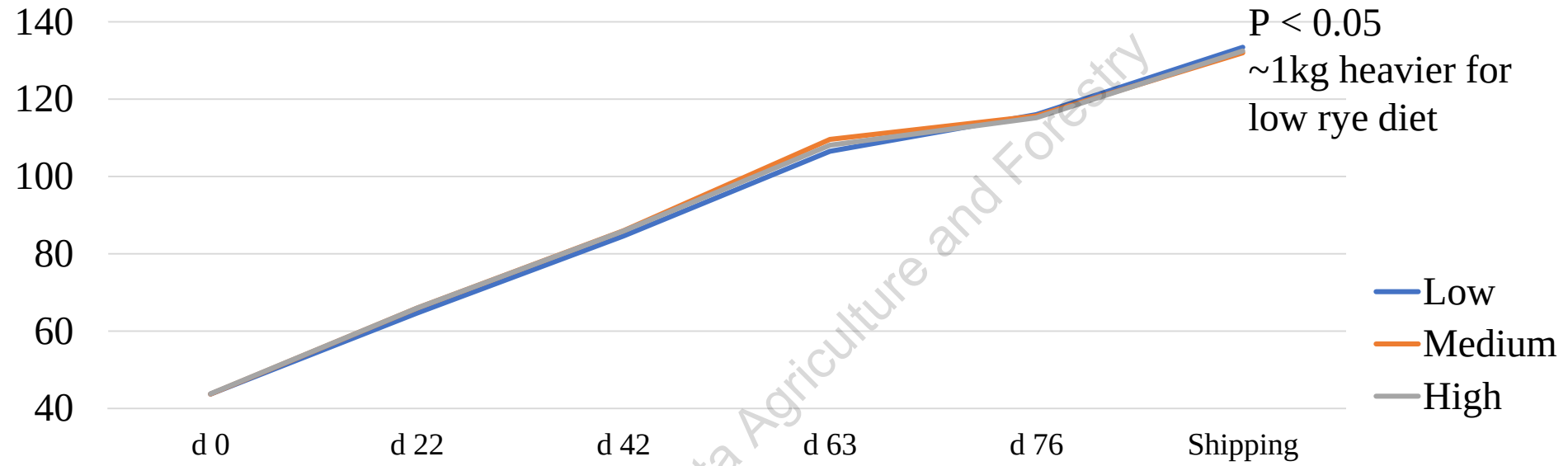
Ergot alkaloids (in ng/g)

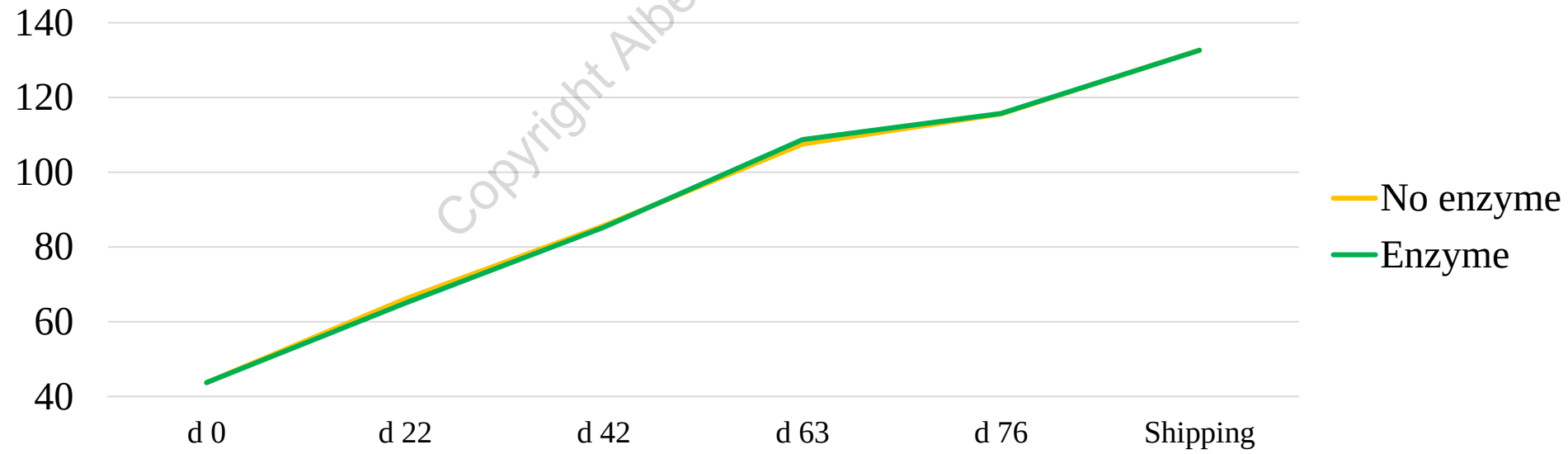
	Wheat			Hybrid rye	
	Batch 1	Batch 2	Batch 3	Batch 1	Batch 2
Ergometrine	ND	ND	ND	ND	ND
Ergosine	ND	20-40	ND	ND	ND
Ergocornine	ND	200-400	ND	ND	ND
Ergocryptine	ND	200-400	ND	ND	ND
Ergotamine	ND	ND	200-400	20-40	20-40
Ergocristine	ND	ND	ND	200-400	200-400

Mycotoxins

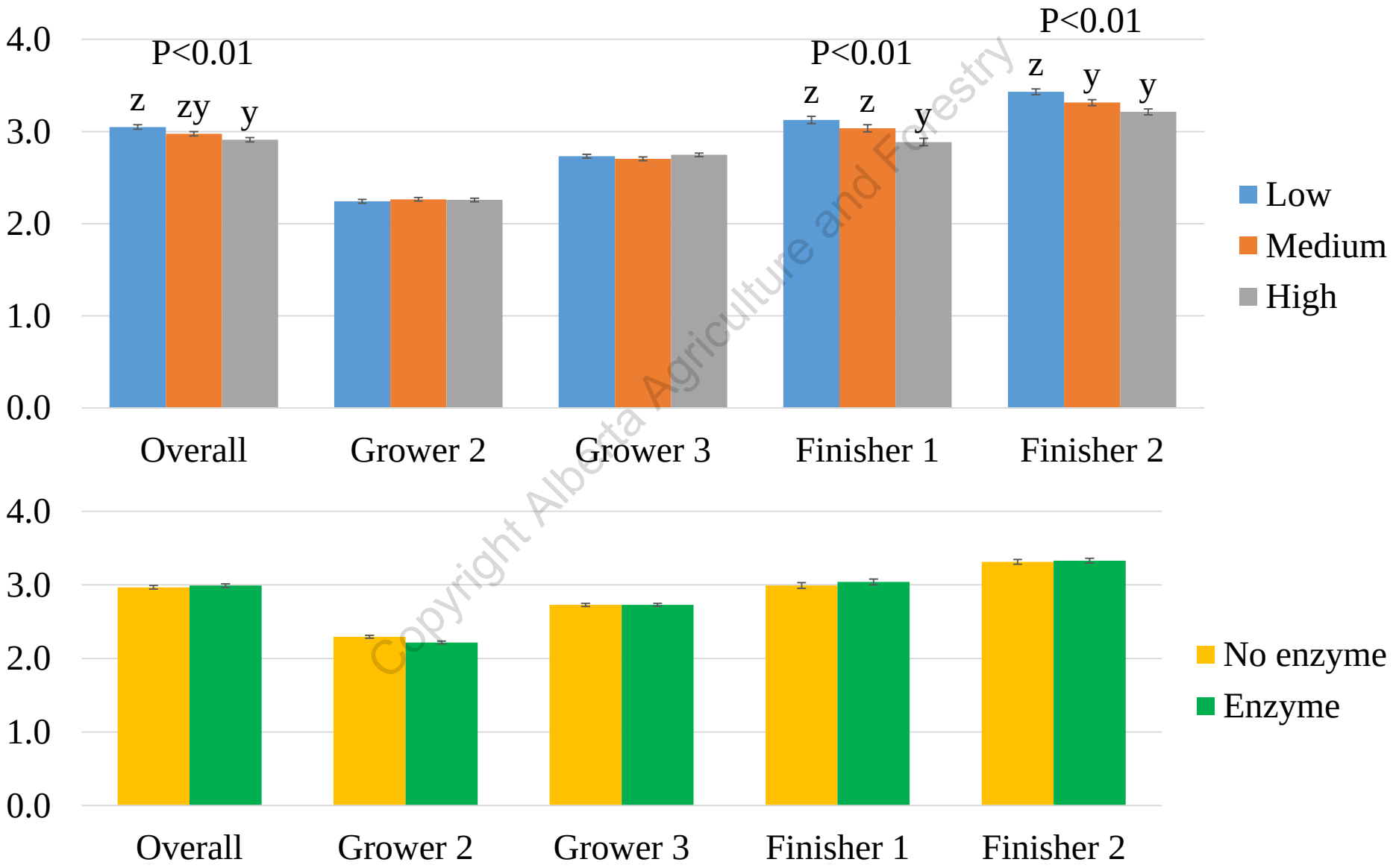
	Wheat			Hybrid rye	
	Batch 1	Batch 2	Batch 3	Batch 1	Batch 2
Vomitoxin (ppm)	0.3	<0.2	0.3	<0.2	<0.2
Fumonisin (ppb)	<222	<222	<222	<222	<222
T-2 toxin (ppb)	<20	<20	<20	<20	<20
Ochratoxin A (ppb)	<5	<5	<5	<5	<5
Zearalenone (ppb)	<5	<5	<5	<5	<5
Aflatoxin (ppb)	<2	<2	<2	<2	<2

Body weight, kg

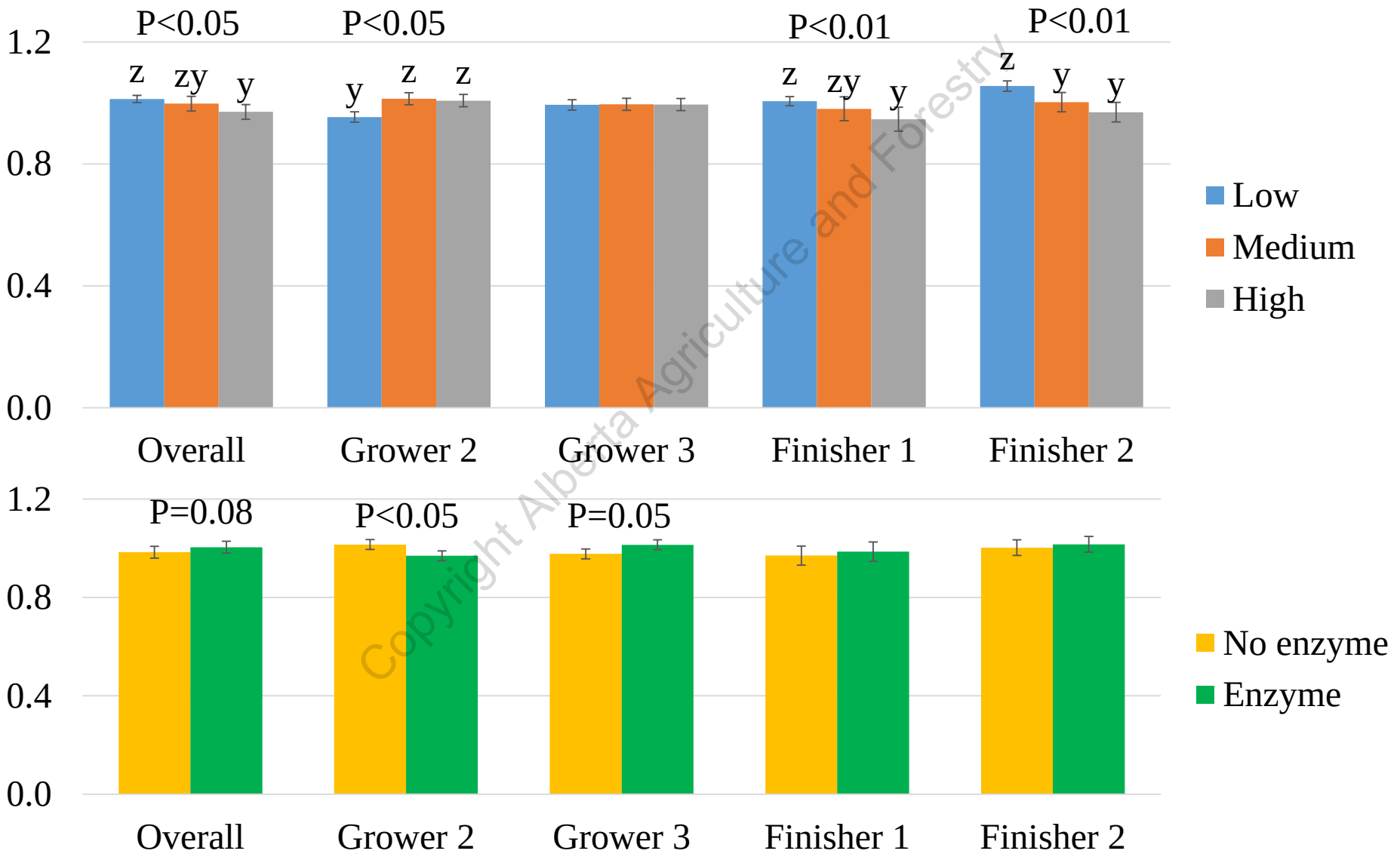




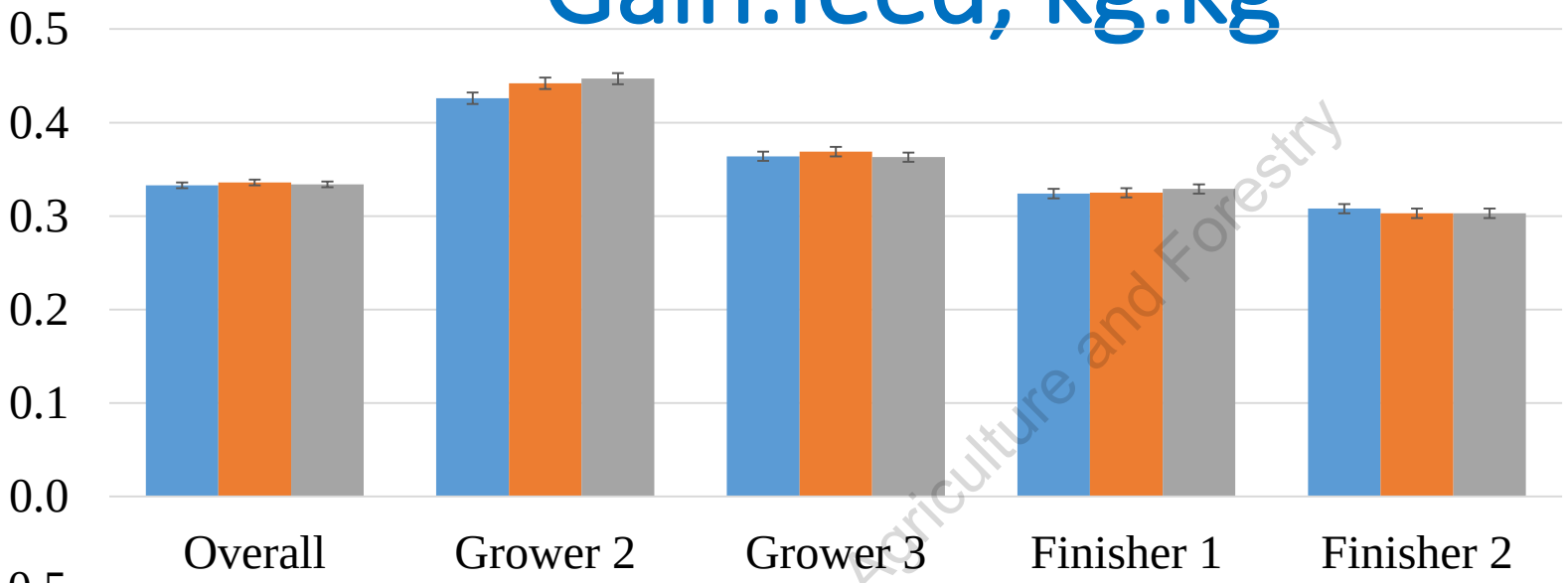
Feed intake, kg/d

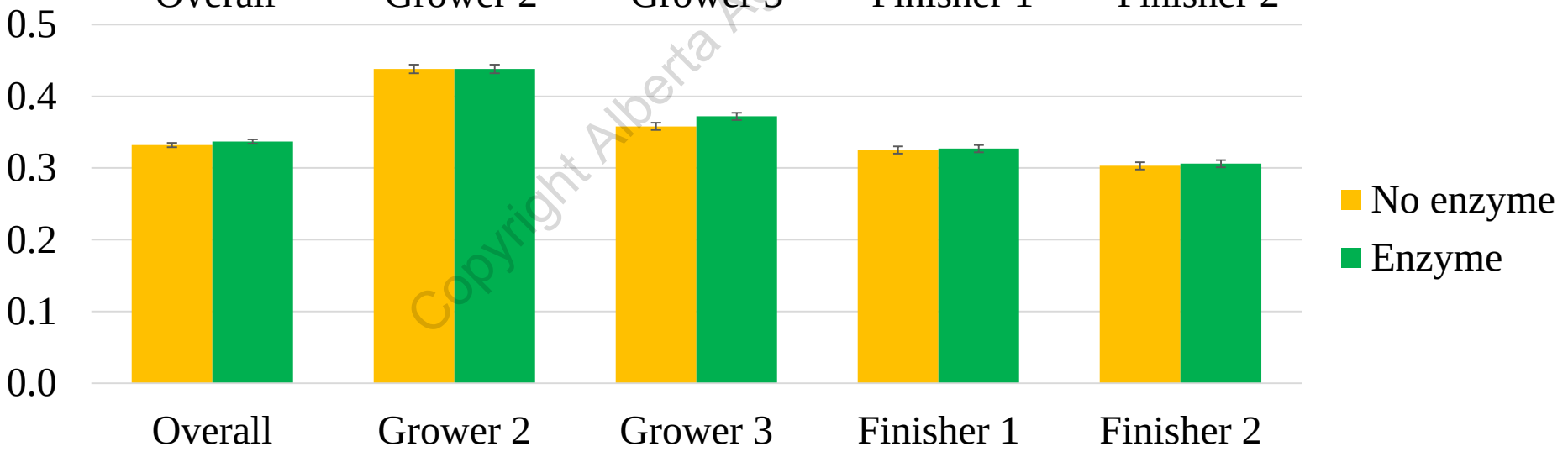


Weight gain, kg/d



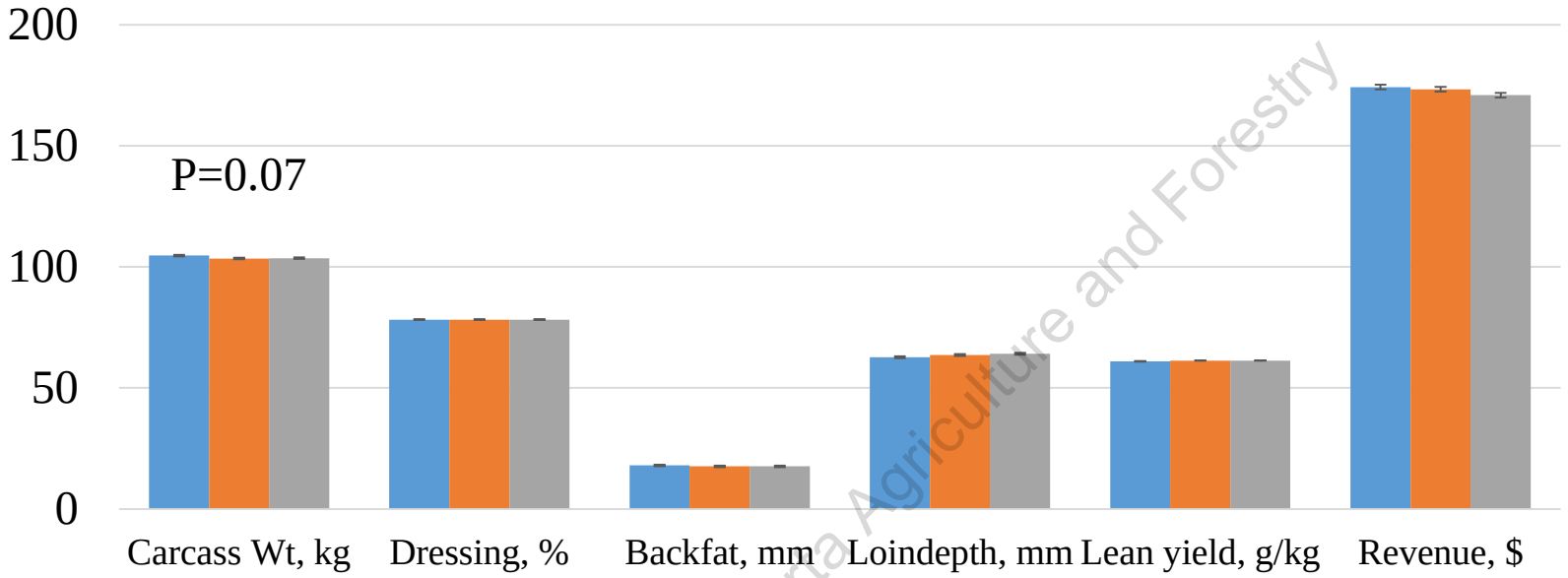
Gain:feed, kg:kg

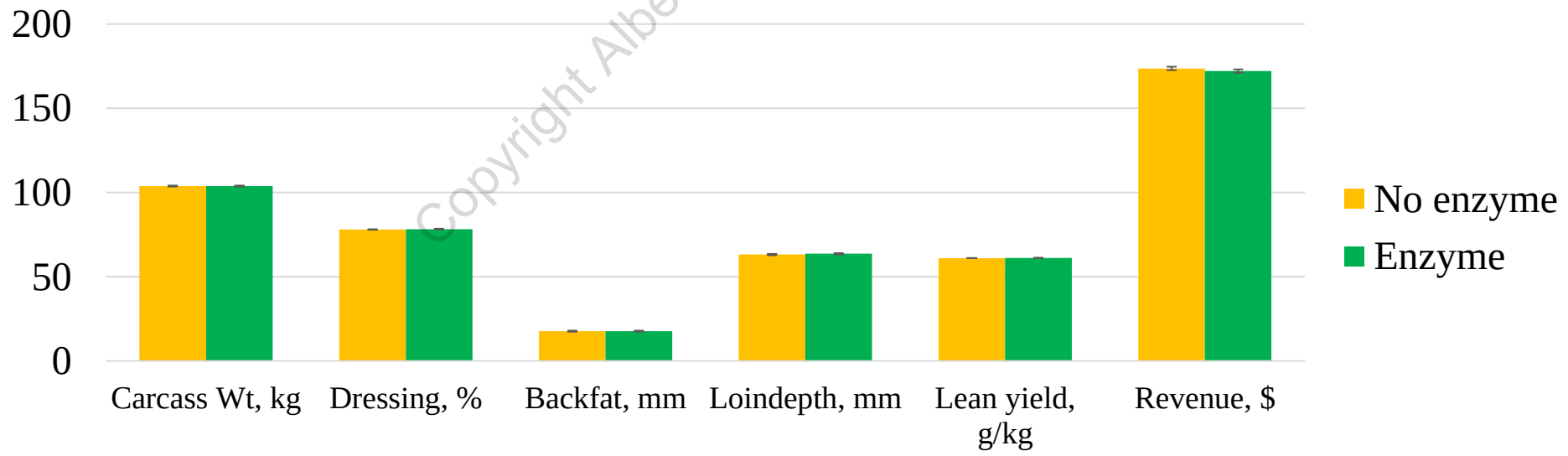




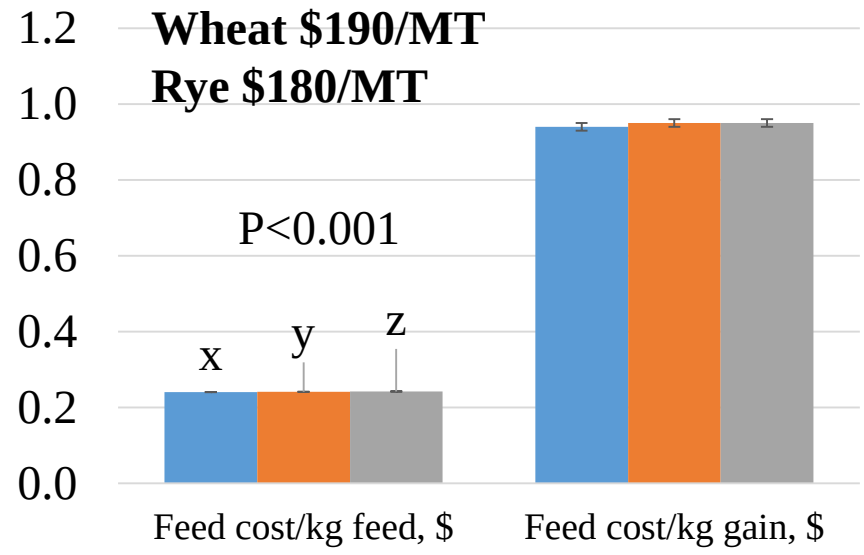
Interaction: Enzyme inclusion improved feed efficiency, but only in pigs fed the high rye diet.

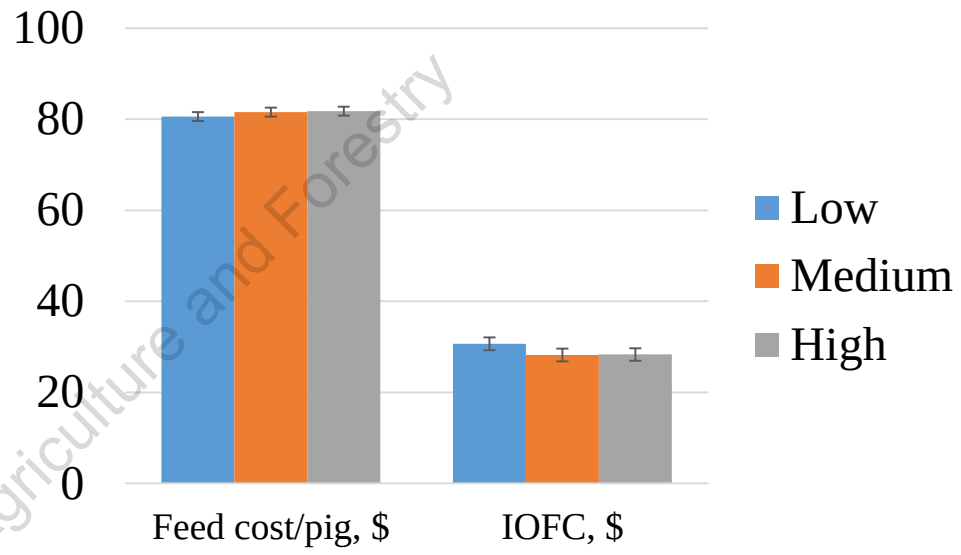
Carcass traits

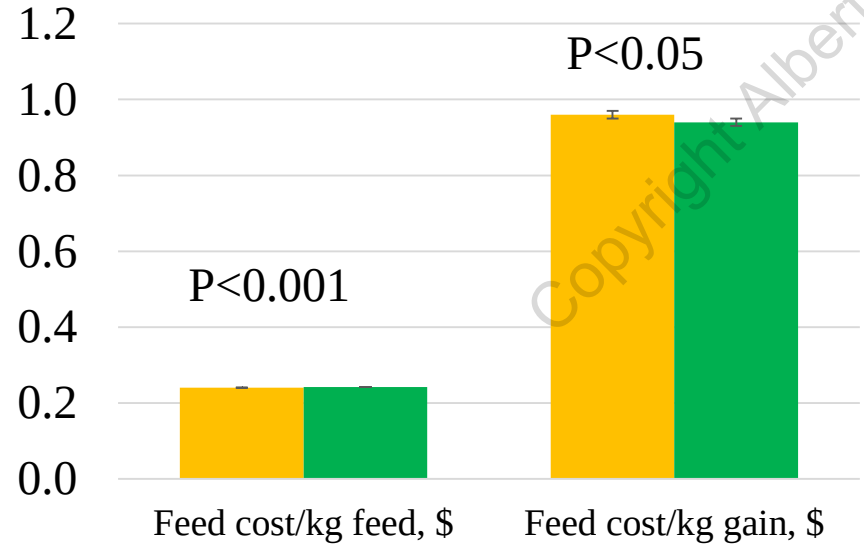


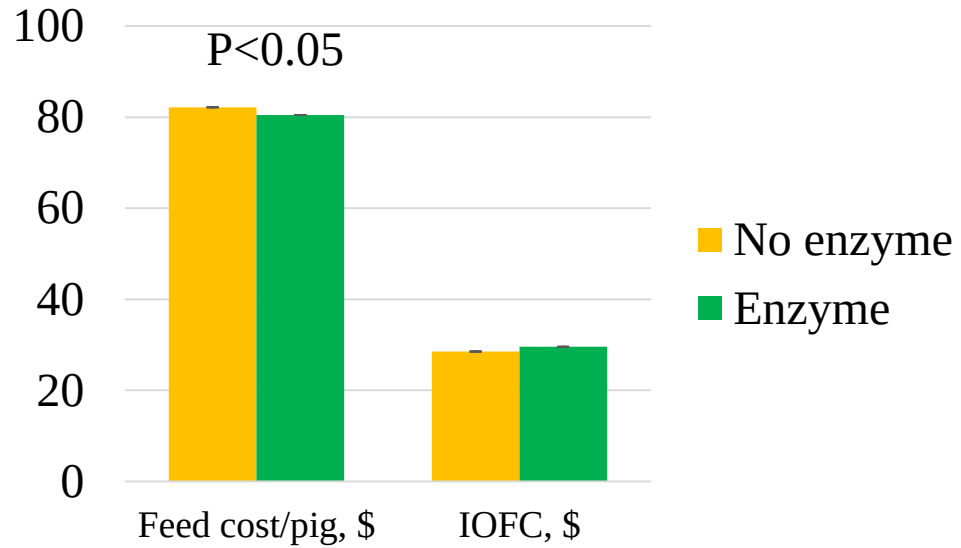


Cost









What these results mean

- Because of the decrease in feed intake with increasing rye level, we first suspected mycotoxins or ergot alkaloids. Both proven not to be the issue.
- Believe the decrease in feed intake observed was caused by the more complex sugars found in rye.
- Increasing gummy sugars made the digesta more viscous (held more water), slowing down passage rate through the gut.
- Hogs felt more full and satisfied with slightly less feed thus reduced their finisher weight gain.
- Both feed intake and weight gain were reduced in parallel, so feed efficiency was not affected.
- Feed NSP enzyme inclusion increased the digestibility/fermentability of the rye sugars, but that only showed up at the high rye level.

What these results mean

- All-rye grain diet likely moved slower along the gut, staying longer and held the most water giving feed enzymes more time to act.
- Carcass dressing was NOT reduced because the rye complex sugars were mostly soluble instead of bulky, insoluble cereal hulls (bran).
- Backfat did NOT increase or decrease because we accounted for the greater rye complex sugars content as a lower net energy value.
- Loin depth was NOT affected because we correctly accounted for differences in amino acid digestibility between rye and wheat grain.
- Diets with increasing rye level were more costly than wheat grain diets because oil was added to compensate for the lower rye NE value.

Hogs fed per unit of land

- Assuming **hybrid rye yields 100 vs. wheat 60 bu/acre,**
- Growout rations include 60% cereal grain,
- Pigs started at 43.7kg, FE was 0.323, carcass weight averaged 103.55kg, dressing was 78.06%, lean yield was 61.16%.

103.6	kg carcass /	0.781	dressing =	132.7	kg live at slaughter				
89.0	kg weight gain /	0.323	gain:feed =	275.4	kg feed per hog x	60%	cereal =	165	kg cereal per hog
69.4	kg carcass gain x	0.612	lean =	42.5	kg lean gain				
100	bu/acre rye =	6723	kg/ha	1728	kg lean pork/ha for rye			41	hogs fed/ha of rye
60	bu/acre wht =	4034	kg/ha	1037	kg lean pork/ha for wht			24	hogs fed/ha of wht
		2689	kg differ.	691	more kg lean pork per ha of rye than wht			16	hogs fed/acre of rye
				617	more lb lean pork per acre of rye than wht			10	hogs fed/acre of wht

Hogs fed per unit of land

- Assuming **hybrid rye yields 90 vs. wheat 70 bu/acre,**
- Growout rations include 60% cereal grain,
- Pigs started at 43.7kg, FE was 0.323, carcass weight averaged 103.55kg, dressing was 78.06%, lean yield was 61.16%.

103.6	kg carcass /	0.781	dressing =	132.7	kg live at slaughter			
89.0	kg weight gain /	0.323	gain:feed =	275.4	kg feed per hog x	60%	cereal =	165 kg cereal per hog
69.4	kg carcass gain x	0.612	lean =	42.5	kg lean gain			
90	bu/acre rye =	6050	kg/ha	1555	kg lean pork/ha for rye			37 hogs fed/ha of rye
70	bu/acre wht =	4706	kg/ha	1209	kg lean pork/ha for wht			28 hogs fed/ha of wht
		1345	kg differ.	346	more kg lean pork per ha of rye than wht			15 hogs fed/acre of rye
				308	more lb lean pork per acre of rye than wht			12 hogs fed/acre of wht

Conclusion

- Hybrid rye can completely replace wheat grain in growout hog diets without affecting feed efficiency, feed cost/hog or feed cost/kg BW gain.
- Inclusion of feed NSP enzymes would be recommended for diets containing high rye inclusion levels (45 – 65% of the diet) to improve feed efficiency and weight gain.

Thank you!

- We thank **Tanya Hollinger, Neil and John Burden** at the test barn for care of the animals.
- Thanks to **Lewisville Pork Farm** for the use of their animals and **Sunhaven Farms Milling** for mixing and supplying the feed.

Hybrid rye replacing wheat grain for hogs

Miranda N. Smit, Xun Zhou, José L. Landero,
Malachy G. Young, and Eduardo Beltranena

Alberta
Agriculture
and Forestry

Gowans
FEED CONSULTING