

With the combination of the benefits and costs, the effectiveness of implementing batch farrowing needs to be evaluated. If this production tool is economically justifiable, it can be an excellent approach for optimization of the farms and management of larger pig flows.

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## AN UPDATE ON CANOLA MEAL UTILIZATION IN SWINE RATIONS

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### Introduction

Canola meal is the main co-product of the canola seed crushing industry and is the most commonly used protein supplement in swine diets after soybean meal. Although it has a slightly less protein content than soybean meal (Woyengo *et al.*, 2014), canola meal has an excellent amino acid composition (Khajali and Slominski, 2012). Also, canola meal contains higher amount of fiber, which along with the antinutritional factor, glucosinolates, have been cited for its limited utility in swine rations (Nyachoti *et al.*, 2004; González-Vega and Stein, 2012; Mejicanos *et al.*, 2016). Thanks to genetic and technological advancements, canola varieties with significantly lower contents of antinutritional factors and production of canola meal of superior nutritive value are now available to the swine industry.

In recent years, there has been a concerted interest in re-evaluating the utilization of canola meal in swine diets so as to take advantage of these developments. Furthermore, recent advances in diet formulation strategies make it possible to effectively utilize different co-products in swine diets. Such diet formulation strategies include the use of net energy and standardized ileal digestible amino acid systems as recommended by the National Research Council (2012). In this review results of recent studies completed at the University of Manitoba on the utilization of canola meal in swine diets are presented.

### Key findings of recent canola meal research at the University of Manitoba:

- Canola meal can be included up to 25% in diets for weaned pigs without compromising growth performance as long as such diets are formulated on net energy and standardized ileal digestible amino acid systems.
- Canola meal can be included up to 30% in lactating sow diets without affecting sow and litter performance measures as long as such diets are formulated on the basis of the net energy and standardized ileal digestible amino acid systems.
- Dehulled canola meal using sieving technology can be well incorporated in weaner pig diets with improvement in body weight gain, feed intake, and feed efficiency.



- The composition of the main feed ingredients (corn vs. wheat) in the basal diet influences feed efficiency in weaner pigs when diets are formulated to contain high canola meal content.
- Results of several studies show that the standardized total tract digestibility of phosphorus for *Brassica napus* black and *Brassica juncea* yellow is 30.7 and 28.3%, respectively.

### Canola Meal Nursery Pig Diets

#### Study 1: Canola meal inclusion level in nursery pig diets

In a series of experiments, the effect of dietary canola meal (CM) inclusion on nursery pig growth performance was investigated. Canola meals from *Brassica napus* black (BNB) and *Brassica juncea* yellow (BJY) were used in these studies. In the first experiment, 168 weaned pigs (initial BW = 7.61 ± 0.76 kg) were fed wheat-soybean meal-based diets containing 0, 5, 10 or 15% of CM derived from either BNB or BJY for a 4-week period post-weaning. An important step in these studies is that diets were formulated to be similar in their net energy and standardized ileal digestible lysine content. There were no differences in growth performance among treatments. In the second experiment, 162 weaned pigs (initial BW = 7.26 ± 0.70 kg) were fed a wheat-soybean meal-based diet containing 0, 20 or 25% of either BNB or BJY without or with supplementation with a multi-carbohydrase enzyme. Again, these diets were formulated to similar net energy and standardized ileal digestible lysine contents. The main results of these experiments are summarized in Figures 1, 2, 3, and 4. These results clearly demonstrated that it is possible to include up to 25% CM in nursery pig diets without compromising growth performance. However, for this to be the case it is critical that such diets are formulated based on net energy and standardized ileal digestible amino acid contents (Sanjayan *et al.*, 2014). It was also evident that supplementing pig diets with high CM inclusion improve energy and nutrient digestibility. Even though the addition of enzymes improved the energy and nutrient digestibility, those improvements were not reflected in the animal performance.

Figure 1. Body weight gain and feed intake of pigs fed increasing levels of canola meal (Exp 1)

Adapted from Sanjayan *et al.*, 2014

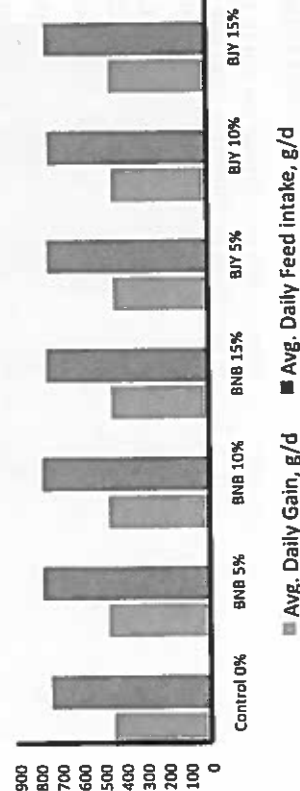


Figure 2. High dietary canola meal inclusion in nursery pig diets had no effect on feed efficiency (Exp 1)

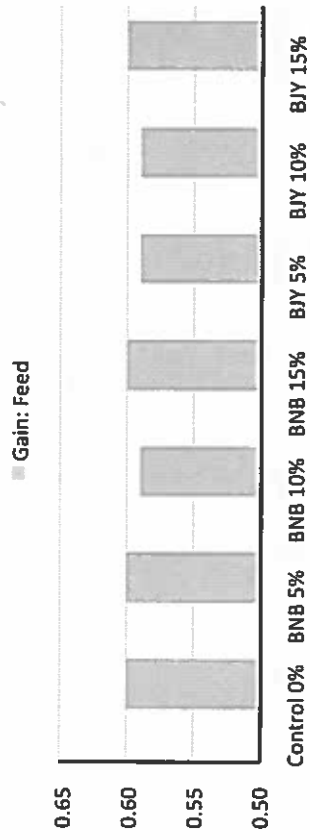


Figure 3. Body weight gain and feed intake in pigs fed increasing levels of canola meal (Exp 2)

Adapted from Sanjayan *et al.*, 2014

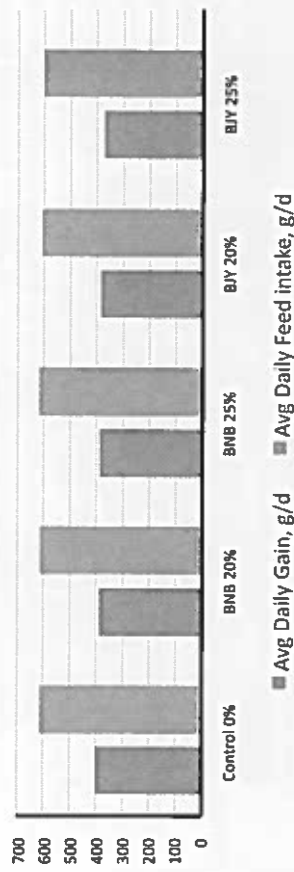
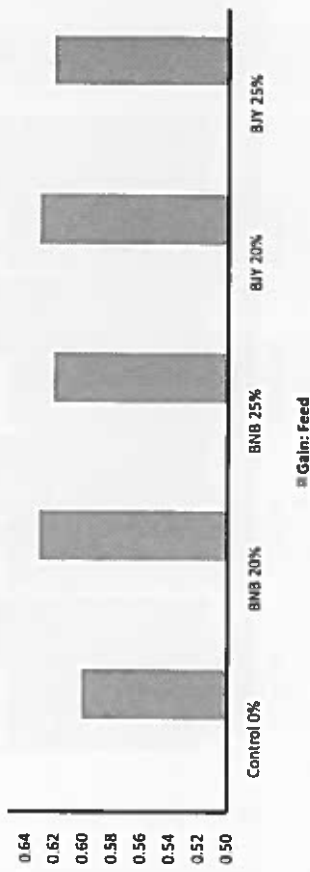


Figure 4. Feeding increasing levels of canola meal to weaned pigs had no effect on feed efficiency (Exp 2)



Study 2: Effect of high canola meal inclusion in wheat or corn-based nursery diets

The aim of the study was to determine whether the composition of the main feed ingredients in the diet influences piglet response to a high dietary CM inclusion as indicated by growth performance, apparent total tract digestibility, and selected gut bacteria measurements. Ninety-six weaned pigs (average initial body weight of 6.71 kg) were used in this 28-d feeding study. Pigs were fed a corn-soybean meal diet or a wheat-soybean meal diet, each without or with 20% CM. A two-phase feeding program was used (phase I, 1-14 and phase II, 15-28-day post-weaning). Average daily gain (ADG), average daily feed intake (ADFI) and feed efficiency (G:F) were recorded weekly. Freshly voided fecal samples were collected on day 21 and 27 to determine protein and energy digestibility and gut bacteria. Results of this study showed no significant differences in feed intake, growth rates (Figure 5), and final body weight among treatments. However, pigs fed the wheat-CM diet had higher feed efficiency (Figure 6) compared with those fed the corn-soybean meal diet (0.95 vs. 0.79) during phase 1. As can be observed in Figure 7, the digestibilities of energy and protein in pigs fed the corn-soybean meal diet were higher than for piglets fed the corn-canola meal, wheat-soybean meal and wheat-canola meal diets (96.6 vs. 89.0, 90.9 and 87.2%; and, 95.3 vs. 89.6, 90.8 and 86.9%) during phase 2. Significant differences were observed for *Lactobacillus*, *Clostridium* cluster IV and *Enterococcus*. In the wheat-based diets it was observed a reduced number of *Lactobacillus* compared to the corn-based diets. Likewise, the relative numbers of *Enterococcus* were reduced. However, as observed in Figure 8, when compared to corn-based diets, wheat-based diets had higher relative numbers of *Clostridium* Cluster IV, related to the release of butyrate, an important source of energy for cells of the large intestine and associated with gut health. In conclusion, results indicated that the composition of the main feed ingredients in nursery pig diets influences feed efficiency, energy and nutrient digestibility and selected gut bacteria when canola meal is included at 20% without affecting voluntary feed intake and piglet growth rates.

Figure 5. ADFI and ADG pre-starter diets

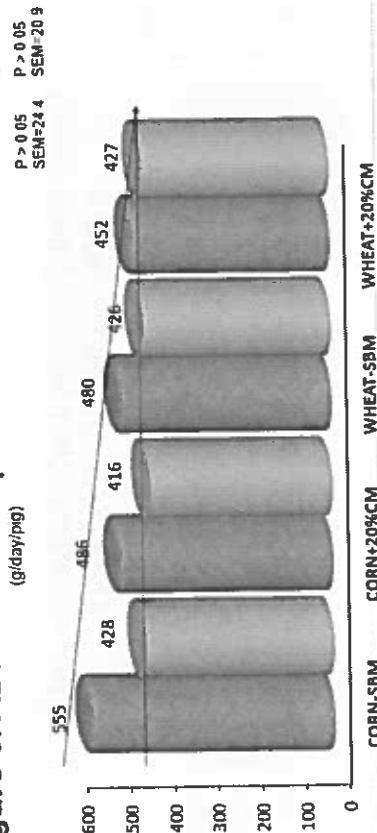


Figure 6. G:F ratio Pre-starter diets (g gain / g feed)

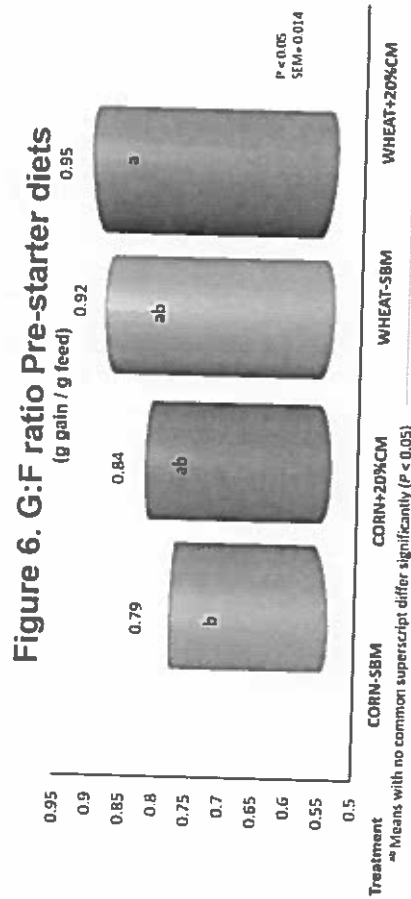


Figure 7. Digestibility of Energy and Protein (%)

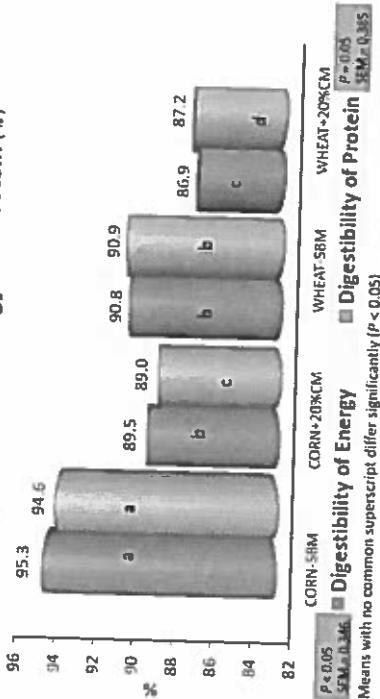
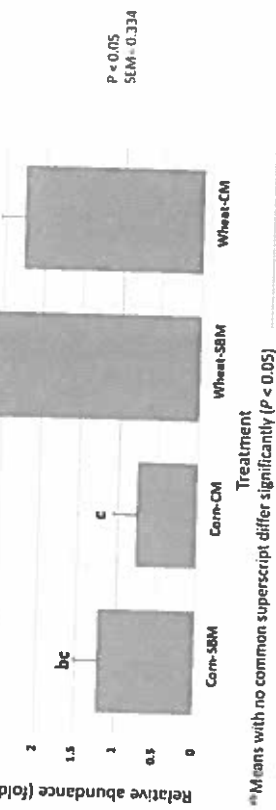


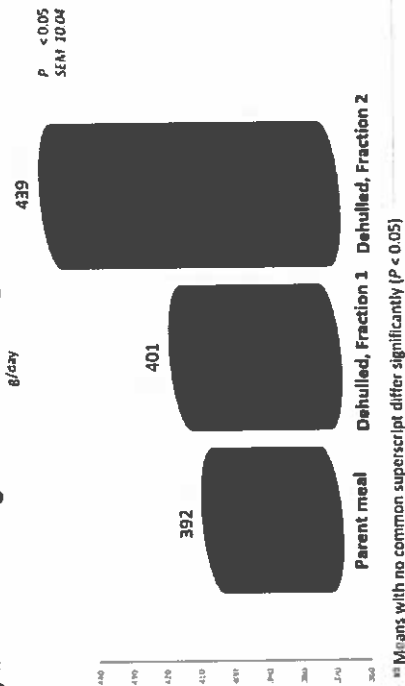
Figure 8. The effect of diet composition on the relative abundance of Clostridium cluster IV using real-time PCR



**Study 3: Effect of feeding diets containing conventional and dehulled canola meals to nursery pigs**

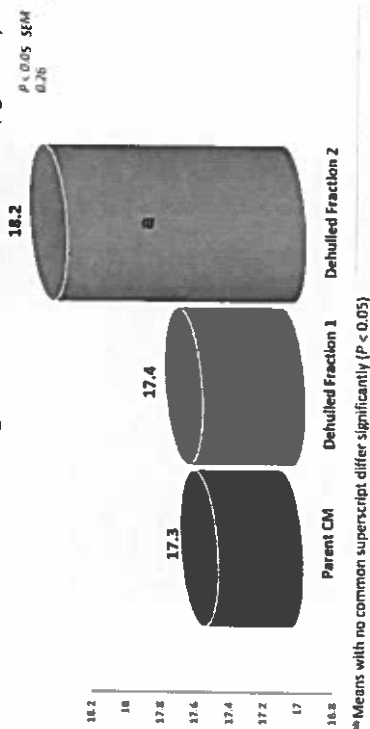
Canola-meal fractionation has been identified as a possible means to reduce fiber and increase the protein content of the meal. In our studies, two distinctive high-nutrient density fractions referred to as Fraction 1 and 2 were produced through sieving technology. Compared to the parent meals, the contents of total dietary fiber in Fractions 1 and 2 decreased from 30.0 to 21.4 and 26.7% for *B. napus*, and from 25.5 to 15.3 and 18.7% for *B. juncea* meal, respectively. Likewise, crude protein increased from 36.8 to 42.0 and 39.6% for *B. napus*, and from 42.3 to 47.9 and 46.8% for *B. juncea* meal, respectively. Thus, we conducted a trial to investigate the effect of feeding diets containing these dehulled meals from *B. napus* and *B. juncea*, on growth performance of weaned pigs. A total of 168 weaned pigs with initial body weight (BW) of 6.86 kg were used in this 28-day study. Experimental diets consisted of a corn and soybean meal-based control diet and 6 diets containing 15% of parent, Fraction 1 or Fraction 2 CM derived from either, *B. napus* or *B. juncea*. A two-phase feeding program was used (phase I, 1-14 and phase II, 15-28 d post-weaning). Diets were formulated according to the net energy and standardized ileal digestible amino acids systems. Average daily gain, average daily feed intake, and feed efficiency were recorded weekly. The type of diet, type of canola or dehulling did not influence feed intake at any time during the trial. Figure 9 shows the effect of dehulling on average daily gain, overall, pigs fed diets containing *B. napus* Fraction 2 meal increased average daily gain by 57 g/day compared to those fed the corn-soybean meal-based control diet. Also, pigs fed diets containing dehulled Fractions 2 increased final body weight at the end of the 28-day study by 1.6 kg, compared to those fed the control corn-soybean meal diet as can be observed in Figures 10 and 11. Dehulling increased feed efficiency in *B. napus* meals, but not in *B. juncea* meal, as can be observed in Figure 12. Thus, it was concluded that the use of *B. napus* dehulled meal at the inclusion level of 15% in nursery pig diets could result in increased final body weight, better average daily gain and better feed efficiency. Moreover, the use of conventional CM in combination with soybean meal could be beneficial and result in better body weight gain than using soybean meal alone.

**Figure 9. Dehulling effect on average daily gain** (Phase II, 15 to 28d)



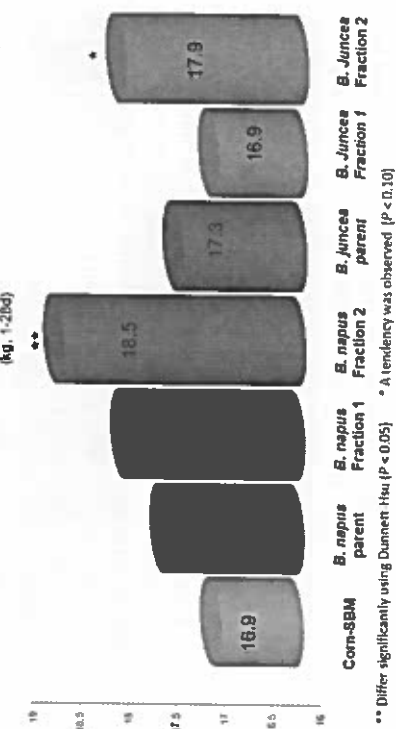
Means with no common superscript differ significantly ( $P < 0.05$ )

**Figure 10. Dehulling effect on final BW** (kg, 1-28d)



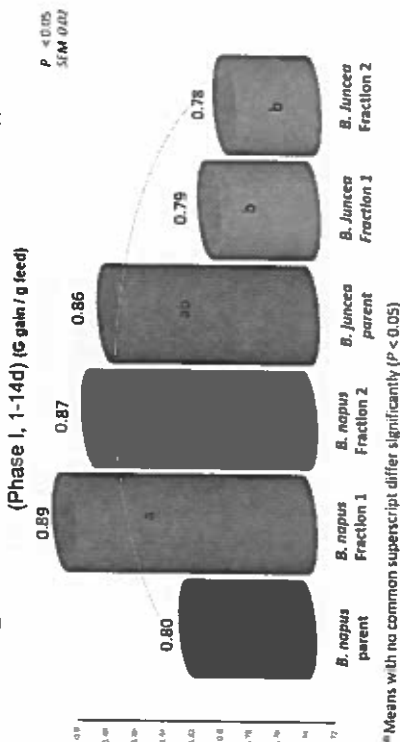
Means with no common superscript differ significantly ( $P < 0.05$ )

**Figure 11. Treatment effect on final BW of weaned pigs** (kg, 1-28d)



Means with no common superscript differ significantly ( $P < 0.05$ ) \* A tendency was observed ( $P < 0.10$ )

**Figure 12. Canola x Dehull effect on G:F** (Phase I, 1-14d) (G gain / G feed)



Means with no common superscript differ significantly ( $P < 0.05$ )

### Canola Meal in Sow Diets

#### Study 4: Effect of feeding higher inclusion levels of canola meal to lactating sows

To our knowledge, not much research has been conducted to evaluate the effects of feeding high levels of CM on lactating sow and piglet performance. If sow nutrient requirements are not met, mobilization of body reserves could occur, having detrimental consequences on both reproduction and piglet survivability. For our study, we hypothesized that optimal performance in lactating sows can be maintained by feeding diets containing higher levels of CM if such diets are formulated on the basis of net energy and standardized ileal digestible amino acid systems. Hence our objective was to determine the effects of higher dietary CM inclusion in lactation diets on reproductive performance of sows with diets formulated on the basis of net energy and standardized ileal digestible amino acid.

The study was conducted at the Glenlea Swine Research Unit, University of Manitoba with 45 sows and their litters. A week before the expected day of farrowing, sows were moved from gestation pens to individual farrowing crates and were fed one of three experimental diets until weaning. The three experimental diets consisted of a corn-soybean-meal control diet containing 0, 15 or 30% CM. Sows were fed 3.0 kg of their respective experimental diets once daily until farrowing. After farrowing, feed was gradually increased over a one-week period, after which the respective diets were offered *ad libitum* until weaning. The quantity of feed provided and the feed refusals per sow were recorded daily to determine the average daily feed intake (ADFI) by sows. Sow body weight and backfat depth were measured and recorded on day 111 of pregnancy, immediately after farrowing (day 0), day 7 post-farrowing and at weaning (day 21). Milk samples were collected from sows on day 0, 7 and 21 post-farrowing to determine the milk composition. Total number of piglets born alive and number of piglets weaned per sow was recorded and litters were weighed on day 0, 7 and 21 to calculate average daily body weight gain. Since excessive mobilization of body reserves can result in lack or absence of the expression of estrus in sows, detection of estrus was conducted post-farrowing to determine weaning to estrus interval.

The results from the study showed no negative effects of high dietary CM inclusion in lactating sow diets on lactation feed intake, sow body weight and backfat change, weaning to estrous interval and milk composition (Figure 13, milk composition data not shown). The breeding of canola has resulted in cultivars with low concentrations of anti-nutritional factors (mainly glucosinolates; < 30 µmol/g), making it a conventional feedstuff for swine. Sows can tolerate a maximum level of 4 µmol/g of total glucosinolates in diets, above which their reproductive performance has shown to be negatively affected. The CM used in the present experiments contained moderately low levels (7.9 µmol/g) of glucosinolates, which means the CM diets contained even lower contents of glucosinolates when compared to its maximum threshold in sows. Thus, the lack of differences in ADFI between sows fed the control diet and CM containing diets in the current study could be due to the fact that the concentration of glucosinolates in diets was within the tolerance level for sows. In the present study, the milk composition was also un-affected with higher CM inclusion; possibly because the diets were formulated to contain similar standardized ileal digestible amino acid contents. Furthermore, there were no negative effects of dietary CM inclusion on

piglet ADG (Figure 14). Thus, it was concluded that inclusion of up to 30% CM in lactation diets can support satisfactory sow and suckling piglet performance when such diets are formulated on the basis of net energy and standardized ileal digestible amino acid systems. Sow and litter performance from the present study also indicate that CM could be used as a single protein source in lactating sows. Presently, a study is undergoing at the University of Manitoba looking into the effect of high dietary CM inclusion from early gestation, on lactating sow and litter performance.

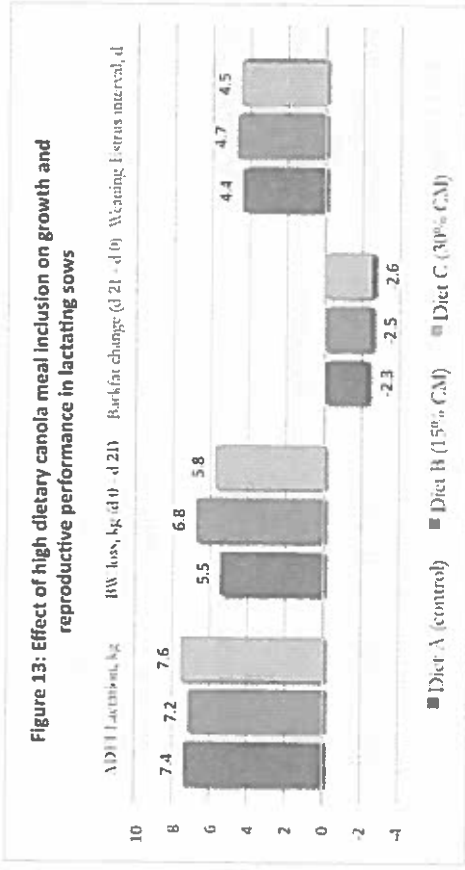


Figure 13: Effect of high dietary canola meal inclusion on growth and reproductive performance in lactating sows

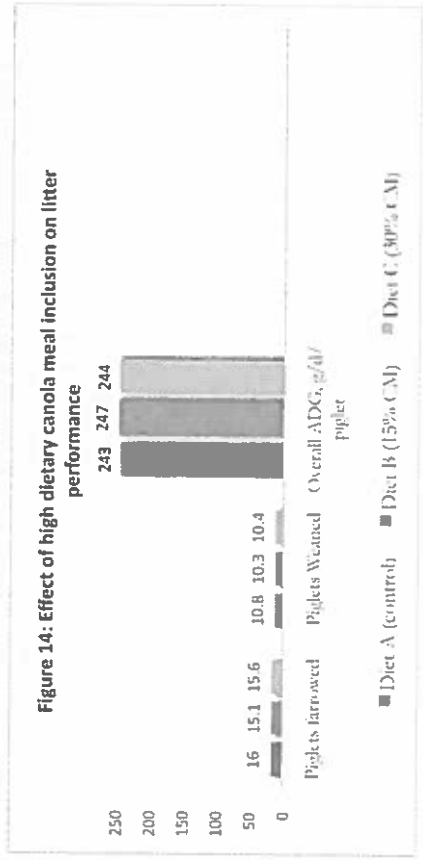


Figure 14: Effect of high dietary canola meal inclusion on litter performance



### Take home message

Adapting to net energy system of feed formulation along with using standardized ileal digestible amino acid concept will allow nutritionist to use high fiber ingredients like canola meal without affecting pig growth performance and carcass quality. Research studies at the University of Manitoba, along with those completed at other Canadian and US research institutions have clearly shown that canola meal can be supplemented at higher inclusion levels in weaned pig and lactation sow diets as a sole source of protein without any losses in performance. Moreover, processing techniques like sieving in canola meal have shown to improve the performance and feed efficiency in pigs, thereby allowing the use of canola meal without affecting the animal performance.

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## SHINING A LIGHT IN THE DARKNESS: TEAM BUILDING AND SUSTAINING RELATIONSHIPS IN YOUR OPERATION

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In order to succeed in agriculture, you have to succeed as a team. It's not just about working hard; it's about working together. Every person on the farm and in industry is capable of contributing at his or her level of responsibility to produce quality pork and provide superior animal care. The pork industry in particular is complex, and everybody's contribution is vital to maintain Manitoba pork as a powerhouse in pork production.

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