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Source: Canadian Journal of Animal Science, 101(4) : 781-787

Published By: Canadian Science Publishing

URL: https://doi.org/10.1139/cjas-2021-0027

NRC Research Press

ARTICLE

Pre-farrow enrichment with burlap sheet: potential benefit for sow performance

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Abstract: Burlap has been proposed as an enrichment option for the conventional farrowing crate environment. Our objectives were to determine if burlap sheets hung in farrowing crates were used by sows and piglets and had any effect on farrowing and litter performance. Before sow entry, a sterilized burlap sheet (165 cm × 60 cm) was attached to every second farrowing crate so that it hung to the floor with easy animal access. Its length was measured immediately after farrowing and weaning. Routine sow and litter information from farrowing to weaning (day 18) were recorded. Complete data were analyzed for mixed-parity sows and litters with burlap (BURL; $n = 277$) and without burlap (CTRL; $n = 277$). Sows and their litters manipulated the burlap sheet to varying degrees. The BURL sows had a lower percentage of stillbirths (6.5% vs. 8.3%, BURL vs. CTRL, SE 0.4; $P = 0.004$), although there was only a trend towards more born alive (13.00 vs. 12.54, SE 0.25; $P = 0.113$). More piglets were fostered off BURL sows (8.4 vs. 7.1, SE 0.5; $P = 0.049$). No significant differences were apparent for other sow and litter measurements. Burlap sheets as a farrowing crate enrichment have potential to improve sow and litter performance.

Key words: enrichment, farrowing, burlap, jute, productivity, sow, swine.

Résumé : La toile de jute a été proposée comme option d'enrichissement pour l'environnement traditionnel de la cage de parturition. Nos objectifs étaient de déterminer si les des étoffes en toile de jute suspendues dans les cages de parturition étaient utilisées par les truies et les porcelets, et si elles avaient un effet sur la performance de cochonnage et de portée. Avant l'entrée de la truie, une étoffe stérilisée en toile de jute (165 cm × 60 cm) a été fixée à toutes les deuxièmes cages de parturition de sorte qu'elle pend jusqu'au sol pour un accès facile par les animaux. Sa longueur a été mesurée immédiatement après le cochonnage et après le sevrage. Les informations de routine au sujet de la truie et de la portée de la mise bas jusqu'au sevrage (jour 18) ont été enregistrées. Les données complètes ont été analysées pour les truies à parité mixtes et les portées avec la toile de jute (BURL — « burlap »; $n = 277$) et sans toile de jute (CTRL — « control » ou témoin; $n = 277$). Les truies et leurs portées ont manipulé l'étoffe en toile de jute a différents degrés. Les truies BURL avaient un plus faible pourcentage de mortinatalité (6,5% c. 8,3%, BURL c. CTRL, SE 0,4; $P = 0{,}004$) bien qu'il n'y a qu'une tendance vers un plus grand nombre né vivant (13,00 c. 12,54, SE 0,25; $P = 0{,}113$). Plus de porcelets ont été mis en adoption simple à partir de truies BURL (8,4 c. 7,1, SE 0,5; $P = 0{,}049$). Aucune différence significative n'était apparente pour les autres mesures des truies ou des portées. Les étoffes en toile de jute comme enrichissement de la cage de parturition ont le potentiel d'améliorer la performance des truies et de leurs portées. [Traduit par la Rédaction]

Mots-clés : enrichissement, cochonnage (parturition, mise bas), toile de jute, jute, productivité, truie, porcs.

Introduction

Farmers in Canada are expected to incorporate environmental enrichment into sow housing according to the Code of Practice for Care and Handling of Pigs [National Farm Animal Care Council (NFACC) 2014]. This is also the case in other parts of the world, for example, the European Union (EU Council 2008). Although recommendations for suitable enrichment materials for pigs are available [Centre de développement du porc du

Received 8 March 2021. Accepted 7 June 2021.

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Québec inc. (CDPQ) 2014; Agriculture and Horticulture Development Board (ADHB) Pork 2018; van de Weerd and Ison 2019], there are relatively few options identified as suitable for sows in conventional farrowing crates, which are still the norm in North America and many European countries. Enrichment can include the addition of materials or structures into the farrowing pen that enhance the sows' and (or) piglets' environment. However, in addition to biosecurity concerns with introducing these additional materials, the design and construction of conventional farrowing crates were intended primarily to protect the newborn piglets, and thus the crates are only slightly wider and longer than the sow. With perforated flooring over liquid manure pits, they are not conducive to the addition of enrichment materials such as straw.

Pre-partum sows have a strong natural motivation to nest-build; efforts to perform this behaviour, which includes rooting, pawing, and searching for suitable materials, are exhibited by sows in farrowing crates, even in the absence of any nest-building material (Jensen 1993; Yun et al. 2014). Frustration of nest-building behaviour in sows can lead to increased levels of stress hormones (Lawrence et al. 1997; Jarvis et al. 2001) and opioids (Jarvis et al. 1997), accompanied by reduced levels of oxytocin (Yun et al. 2013, 2014). These may combine to negatively impact the duration of parturition (Oliviero et al. 2008) and early lactation performance (Yun et al. 2014). Expression of nest-building behaviour was positively associated with lactation performance and early weight gain in piglets (Yun et al. 2014). Therefore, provision of suitable material that allows more natural expression of behaviour associated with nest-building could reduce sow frustration and result in a calmer animal throughout farrowing and lactation with potential production benefits. Such benefits, if demonstrable, would encourage on-farm adoption of enrichment provision for farrowing sows.

Burlap material meets several important enrichment criteria (van de Weerd and Ison 2019). It is investigable, manipulable, chewable and, although not intended to be eaten, it can be ingested without harm, as long as it has been appropriately cleaned and sterilized before introduction to the animal(s). Hanging a burlap sheet in the farrowing crate may allow the sow to safely express more natural nest-building behavior, including oral manipulation and rooting, as well as increase the complexity of the farrowing crate environment. If the sow is more relaxed and continues to use the burlap after farrowing, she may milk better and remain calmer, which will benefit the piglets in terms of pre-weaning survival and growth. For the piglets, being able to chew on the burlap would also be a form of enrichment in that they can engage in their natural tendency to chew and may play with the material. Therefore, potential production benefits could include easier/quicker farrowing, reflected by fewer stillborn piglets per litter, lower pre-weaning mortality, and better piglet growth performance.

Because of additional costs and labour, adoption of any enrichment in commercial farm operations would be more likely if production benefits accrued. After conducting a small trial at the University of Manitoba swine research centre in which we found a trend towards fewer stillbirths from sows provided with hanging burlap sheets pre-farrowing, the current research was conducted on a 1500-sow farrow-to-wean farm in Manitoba, Canada. The objectives of this on-farm project were to quantify the use of hanging burlap material provided to sows in farrowing crates pre-farrowing and the use of it post-farrowing by the sow and her litter; to determine if introduction of hanging burlap pre-farrowing results in fewer farrowing difficulties, e.g., stillborn piglets; and to determine if access to hanging burlap material in the farrowing crates results in better piglet performance.

Materials and Methods

The research was conducted in accordance with the Canadian Code of Practice for the Care and Handling of Pigs (NFACC 2014) between October 2018 and January 2019 on a 1500-sow farrow-to-wean farm in Manitoba using Genesus genetics (Genesus Inc., Oakville, MB, Canada). Each of seven farrowing rooms, housing 32 standard farrowing crates (228 cm × 61 cm) with associated creep area (228 cm × 46 cm) along each side, was filled with one farrowing group of sows on the same day. A commercial lactation ration formulated to meet their requirements according to the National Research Council (2012) was fed to sows individually, to appetite, following a standard feeding curve.

In total, 626 mixed parity sows were randomly assigned to one of the two treatments, burlap [BURL ($n = 322$)] or control [CTRL ($n = 304$)], at the time of farrowing crate entry (approximately day 112 of gestation; 3–4 d before their expected farrowing date). Pregnant gilts and sows were given 1 cc of Planate (Merck Animal Health) at day 114 (sows) or day 115 (gilts) to induce parturition if they had not already farrowed. Only data from 554 sows were used for analyses; data from the other 72 sows (BURL, $n = 45$; CTRL, $n = 27$) were not used as the number of piglets weaned could not be reconciled with the numbers that were born alive, fostered, or died, or the sow died prior to weaning. Data from the remaining 277 sows per treatment group were represented with similar parity distributions in the two groups (3.8 ± 2.6 and 3.9 ± 2.6; mean ± SD, for BURL and CTRL groups, respectively) (Table 1).

Pig measurements and performance records collected included sow weight and back-fat measurements taken at farrowing crate entry and at weaning (days 18.0 ± 1.8 of lactation); routine litter information (total born, born alive, stillborn, fostered, weaned, etc.); individual piglet birthweights; litter weights at 3 d of age and at weaning;

Table 1. Distribution of sows in each parity as a percentage of (*a*) all 554 sows in the dataset (ALL); (*b*) the 277 sows in burlap treatment group (BURL); and (*c*) the 277 sows in the control group (CTRL).

Parity	1	2	3	4	5	6	7	8	9
(*a*) % of ALL	26	18	7	9	10	10	8	10	3
(*b*) % of BURL	29	17	7	6	9	12	7	10	3
(*c*) % of CTRL	24	18	6	11	10	9	9	10	3

Fig. 1. Burlap sheet anchored by a purpose-designed bracket onto a farrowing crate before sow entry pre-farrowing. Sheets were situated about sow shoulder height near the front of the crate, on the opposite side from the nipple drinker. The burlap was then draped over the top bar and adjusted to touch the floor of the crate without interfering with feeding or drinking but be easily accessible to the sow. [Colour online.]

and pre-weaning mortality (due to illness; low viability; savaging; trauma; or other). Sows were weighed (kg) using a Reliable Model 300ILG weigh scale. Backfat measurements (mm) were taken at the P2 position (6 cm away from the dorsal midline at the last rib curve) using a Renco Lean-Meter® digital backfat indicator. Piglets were cross-fostered within a farrowing room to equalize litter sizes as part of normal husbandry practices, with no consideration given to treatment groups.

A new burlap sheet (165 cm × 60 cm; 213 $g \cdot m^{-2}$; MS Schippers; irradiated/sterilized) was anchored to every second farrowing crate ($n = 16$ per room) preceding sows' entry to the farrowing room and removed once sows were weaned. Sheets were anchored into a specifically designed metal bracket, which was fastened onto the bars of the farrowing crate around sow shoulder height near the front of the crate, on the opposite side from the nipple drinker. The burlap was then draped over the top bar and adjusted to touch the floor of the crate without interfering with feeding or drinking but be easily accessible to the sow (Fig. 1). Sows and gilts entering these crates were considered part of the burlap treatment group (BURL). The other 16 crates per room were without burlap; sows and gilts entering these crates were part of the control treatment group (CTRL).

In addition to burlap sheet measurement at the time of installation, the length of each sheet was taken, using a standardized procedure (the longest portion parallel to the long side of the sheet was measured), within 24 h after farrowing and at the time of weaning. The amount removed from each sheet by the sow and (or) piglets was calculated as the total length of the intact sheet (165 cm) minus the length remaining. If the burlap sheet became detached or deteriorated to the point that the sow could no longer access it, it was replaced with a new burlap sheet. This only occurred for nine sows, two of which occurred prior to the post-farrowing measurement. However, due to deviations from the standard

measurement protocol, burlap measurements that occurred after the sheet was replaced were omitted from the dataset.

We consider this experiment to be a randomized complete block design where the group of sows in a farrowing room (32 farrowing crates per room) at the same time made up a "contemporary group", i.e., a group of sows at the same time in similar environmental circumstances. Contemporary group was the blocking variable, with sows randomly assigned to treatment within each contemporary group. There were 22 contemporary groups, with each contemporary group considered a replicate. To simplify the study of parity effects, sows from parities 1 to 9 were grouped into three groups: parities 1–2 (P1_2), parities 3–6 (P3_6), and parities 7–9 (P7_9). There was an even distribution of sows of each parity in the two treatments and within each contemporary group (Table 1).

Variables measured at farrowing and weaning were tested for significance in a mixed model containing the fixed effects of burlap treatment, sow parity group, and the interaction of these two factors; the random effects of contemporary group, the interaction of contemporary group with burlap treatment and sow parity and a residual error. The random interaction term formed the error term for testing hypotheses concerning the fixed effects. For variables representing deaths relative to a litter size at birth or at weaning, the SAS Glimmix procedure (SAS Institute Inc. 2021) was used, and the variables were modeled as binomial variables. All other variables were analyzed using the SAS MIXED procedure. Burlap length changes to farrowing or to weaning were analyzed using a mixed model with the fixed effects of parity group, and backfat measured at farrowing. The random effects included contemporary group and the interaction of contemporary group with parity. A type I error rate of 0.05 was used.

Results

Burlap usage

Chewing and destruction of the burlap sheet between crate entry and post-farrowing was quite variable, ranging from virtually none to the removal of 100 cm, with an average of 15.2 ± 17.8 cm of burlap removed by sows not needing their burlap replaced. Measurements between crate entry and weaning, which included use by the piglets, showed more, but variable, use of burlap, ranging from zero to 132 cm change in burlap length (average 45.5 ± 24.9 cm). There were no significant differences in burlap usage due to parity groups or sow backfat measurements at farrowing.

Sow and litter performance

Farrowing and litter performance are summarized in Table 2. No significant difference was seen in total piglets born, but a trend to more born alive from BURL sows was noted. Sows with access to burlap had a significantly lower percentage of stillborn piglets (6.5% vs. 8.3%, BURL vs. CTRL, respectively, SE 0.4; $P = 0.004$). However, the number of piglets weaned was not significantly different between BURL and CTRL groups. Sows with access to burlap had significantly more piglets fostered off them, as a percentage of total piglets in the litter, than sows without burlap and a tendency to have fewer piglets fostered onto them. There were no significant differences between treatments for any other variables, including pre-weaning mortality (overall, or in days 0–3), piglet or litter weights, average daily gain of piglets, or sow weight or backfat changes between farrowing and weaning. Treatment by parity interaction was not significant for any of the variables studied, indicating that the effects of burlap treatment were not different from parity group to parity group.

Discussion

The variation in the use of the burlap sheets by sows pre-farrowing is consistent with the variation in temperament and disposition of any group of sows. Having access to this enrichment was important to most of the sows because all but a very few sows had obviously chewed on the burlap sheets. It was noted that even sows that chewed on the burlap very little, if at all, interacted with the burlap by nosing it, lying against it, and (or) lying with their head covered by the burlap, suggesting that even those sows used the burlap as a form of enrichment in their environment. Therefore, the addition of the burlap to the farrowing crate appeared to have met an important goal of enrichment by enhancing its environment (van de Weerd and Ison 2019). The fact that no significant differences existed between different parity groups suggests that the provision of burlap is equally beneficial across parities and, therefore, should be provided to all sows and gilts in farrowing.

Although overall litter size weaned was not significantly improved by access to the burlap, the percentage of stillborn piglets was lower for sows with burlap, and there was a trend towards more born alive. This may reflect a shorter farrowing time for sows that have access to this enrichment, but the actual duration of farrowing was not measured. Restriction of normal pre-farrow nest-building behaviour is considered stressful (Jarvis et al. 1997, 2001). Endocrine responses can include lower oxytocin release, which impacts maternal behaviour and duration of parturition (Jarvis et al. 1997, 2001). Satisfaction of nest-building behaviour results in elevated oxytocin, which promotes calmness and decreased anxiety (Uvnas-Moberg et al. 2001). Crated sows provided with manipulable material pre-farrowing reportedly demonstrated increased nest-building behaviour, were more passive during a shorter parturition (Cronin and van Amerogen 1991), tended to have fewer stillborn piglets (McGlone et al. 1996), and had improved lactation performance (Cronin and van Amerogen 1991). Access to the burlap sheet in the current research

Table 2. The effects of burlap treatment and parity on sow and litter performance at farrowing and weaning.

	Treatment			Parity				Significance		
Variable	BURL	CTRL	SE	P1_2	P3_6	P7_9	SE	Treatment	Parity	$T \times P$
Number of sows	277	277	—	245	195	114	—	—	—	—
Sow weight at farrowing (kg)	277.2	280.5	1.9	229.8c	290.0b	316.8a	2.3	0.2258	<0.0001	0.5116
Sow backfat at farrowing (mm)	18.86	19.46	0.33	18.44	19.21	19.83	0.38	0.1916	0.0533	0.5799
Sow weight change, farrowing to weaning (kg)	−25.3	−25.9	1.2	−24.8	−26.4	−25.6	1.4	0.7033	0.6811	0.6367
Sow backfat change, farrowing to weaning (mm)	−1.06	−0.99	0.22	−1.27	−0.92	−0.88	0.25	0.8448	0.4695	0.9767
Total piglets born (alive or dead) per litter	13.95	13.74	0.29	12.83c	14.85a	13.86b	0.31	0.4749	<0.0001	0.4339
Total piglets born alive per litter	13.00	12.54	0.25	12.19b	13.72a	12.40b	0.29	0.1131	<0.0001	0.2288
Average birth weight of individual piglets (kg)	1.38	1.38	0.01	1.36	1.39	1.39	0.02	0.8241	0.3788	0.4024
Average daily gain of piglets from farrowing to weaning ($kg \cdot d^{-1}$)	0.203	0.206	0.004	0.201	0.208	0.204	0.004	0.3700	0.3121	0.7014
Stillborn piglets as percentage of total piglets born per litter (%)	6.5b	8.3a	0.4	5.4c	7.5b	10.0a	0.5	0.0043	<0.0001	0.3914
Piglets fostered onto the sow as percentage of total piglets in the litter (%)	5.8	7.7	0.8	8.9a	4.3b	7.9a	1.1	0.0886	0.0009	0.8145
Piglets fostered off the sow as percentage of total piglets in the litter (%)	8.4a	7.1b	0.5	5.5b	9.2a	9.1a	0.6	0.0487	<0.0001	0.4124
Piglet deaths per litter, days 0–3 as percentage of total piglets in the litter (%)	8.6	8.4	0.6	6.4b	9.4a	10.3a	0.7	0.8672	<0.0001	0.8351
Total piglet deaths per litter as percentage of total piglets in the litter (%)	12.0	12.1	0.8	9.5b	13.0a	14.1a	0.9	0.8655	<0.0001	0.7649
Piglets weaned per litter	11.6	11.5	0.2	11.8a	11.9a	11.0b	0.2	0.4613	0.0002	0.3792

Note: BURL, sows in burlap treatment; CTRL, sows in the control group; SE, standard error; P1_2, parities 1–2; P3_6, parities 3–6; P7_9, parities 7–9; T × P, treatment by parity interaction. Means in the same row for treatment or for parity group which have different superscripts are considered significantly different with Tukey's comparison of means with a type 1 error of 0.05.

allowed oral manipulation and interactions with the material that may have sufficiently satisfied the sows' motivation to nest-build, potentially facilitating enhanced parturition and fewer stillborn piglets. Overall, this research demonstrated that access to burlap can provide a valued enrichment for sows and potentially to piglets.

Pre-weaning litter performance was not measurably affected by access to burlap sheets. However, the normal husbandry practice for this farm was to cross-foster piglets within a farrowing room to equalize litter sizes. Since there was no treatment effect on early piglet mortality (days 0–3) more piglets fostered off the sows with access to burlap indicates that these litters tended to have more piglets alive at the time when fostering would occur (days 1–3 of lactation), potentially from reduced frequency of stillbirths, than the control group. This may suggest there is opportunity to wean more piglets born from sows that are provided burlap than those that are not. If piglets were not cross-fostered between treatment groups, it is possible that the number weaned would be higher for sows given access to burlap. Of course, weaning more piglets also puts a higher demand on lactation and husbandry practices to ensure the additional piglets survive to weaning. But, if the additional piglets resulting from fewer stillbirths are kept alive to weaning, this could potentially result in one extra marketable piglet for every four litters.

Regardless of litter performance, caregivers observed piglets participating in play behaviour with the burlap. Whether this was reflected by less fighting between piglets was not examined but is deserving of further research. Biting behaviour is a major welfare concern in young pigs (Prunier et al. 2020). Pre-weaning enrichment with chewable materials has been demonstrated to reduce biting behaviour in suckling piglets (Schmitt et al. 2020) as well as post-weaning tail-biting (Telkänranta et al. 2014). The protocol for managing the burlap enrichment had it anchored to the farrowing crate throughout the lactation period, which made it more available to the sow but less available to the piglets. Another method that would require further research would be to detach the burlap from the bracket after the sow has farrowed and anchor it in the creep area close to the heating devices, which would make it more available to the piglets but less available to the sow post-farrowing. The intent would be to still provide the enrichment to the sow during the pre-farrowing period when its motivation to nest-build is highest, then fasten it in the creep area to encourage piglets to lie near the heating device(s) and away from the sow to improve survivability.

Conclusion

Burlap sheets hung in the farrowing crates seemed to be valued enrichments for the sows and their litters. Although there was variation in the measurable use by chewing, all sows and litters interacted with the sheets throughout the farrowing and lactation period. The finding of fewer stillborn piglets from sows with access to burlap suggests that access to this enrichment had a physiological benefit for the sows. Even though the conventional farrowing crate environment limits the types of enrichment that can be provided, it was clear that even this simple enrichment provided measurable production benefits and potentially a positive return on investment to the producer.

Competing Interests

The authors declare that there are no competing interests.

Acknowledgements

The research is indebted to Derik Bergmann for carrying out the trials on his farm and collecting the data. We would also like to thank Schippers Canada for generously donating their burlap enrichment product for the research, and Genesus Inc. for allowing us to access and use their database to manage and analyze the research data. Manitoba Pork would like to acknowledge Manitoba Agriculture and Resource Development and the Government of Canada for providing the financial assistance through the Ag Action Manitoba program which made this research possible.

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