



# Effects of group housing on reproductive performance, lameness, injuries and saliva cortisol in gestating sows

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## ABSTRACT

In many countries sows are kept in individual stalls from insemination up to just few days prior to farrowing. The overall objective of this study was to examine group housing management system for sows during gestation as an alternative for individual confinement stalls, and the possible effects on their welfare, production and reproduction performances. Accordingly, the study included three specific objectives: (1) to compare parameters of production, reproduction, and welfare of sows housed in groups (either 30 or 7 sows/group; Large Group: LG, Small Group: SG, respectively) during gestation as compared to individual confinement stalls (IS); (2) to compare saliva cortisol of pregnant sows throughout gestation, when housed in groups of three different sizes (either 7, 15 or 30 sows per pen group); and (3) to compare sows' production and reproduction performances at the herd level, before, during and after practically transforming from a management of individual confinement stalls to a group housing system, in a large commercial swine farm over a six-year period. Mean cycle length (weaning-to-weaning) was shorter in group housing management as compared to individual stalls ( $P = 0.0110$ ), but gestation length did not differ among the three groups. Overall farrowing rate (sows farrowed out of those inseminated) was higher ( $P \leq 0.0134$ ) for sows housed in groups (either SG or LG). Furthermore, there was a tendency towards a higher number of total born ( $P = 0.1033$ ), and born alive piglets ( $P = 0.0862$ ), in group housing system as compared to individual housing management; however, it did not differ between the LG and SG groups. Injuries and lameness index (ILI) of sows improved significantly over the gestation period in group housing management. Group saliva cortisol during gestation did not differ significantly among groups of 7, 15, or 30 sows, except on the first saliva sampling, just after sows were mixed into groups, where cortisol level was significantly higher in sows housed in a pen of 30 sows. Production and reproduction performances at the herd level, over a 6-years period- before, during and after transforming to a group housing system, improved significantly: shortened cycle length, increased farrowing rate, and increased number of total born and born alive piglets. In conclusion, group housing management during gestation was associated with better reproduction, productivity and welfare of sows, as compared to individual stalls. A welfare friendly housing system can be beneficial and effective for both the farmers and the animals.

## 1. Introduction

Pig housing systems around the world are currently changing towards better animal welfare (Tuytens et al., 2011). However, in many countries around the world millions of gestating sows are kept in individual confinement for most of their lives (Kemp and Soede, 2012). There are diverse housing systems for holding sows during gestation; sows can be kept in individual stalls or in group housing systems, indoor or outdoor, or in different combinations of housing arrangements.

In individual stalls, sows are confined in a small space, commonly just slightly larger than the size of their own body, with the ability to only stand and lay down at the same interior to posterior position; but without the ability to turn around or groom normally. It has been shown that blood cortisol concentrations and heart rate are elevated under this stressful condition (Lawrence et al., 1994; Jarvis et al., 1998; Ahmadi et al., 2011; Kemp and Soede, 2012). Restraining may harm the sows physically, with leg injuries and skin lesions being most common (Damm et al., 2010). In addition, housing sows in individual stalls may

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have direct or indirect negative impact on reproduction, as lameness in pregnant sows has been associated with increased number of mummified and stillborn piglets (Anil et al., 2009; Pluym et al., 2013).

In recent years, individual stalls during gestation are being replaced by group housing systems in many countries (Tuytens et al., 2011). According to the European Union legislation, since 2013 individual stalls have been forbidden for most of the pregnancy period of the sows in Europe. There are several types of group housing systems, which mostly differ in group size (from 4 to 5 to 250 sows per group), feeding system (e.g., electronic feeders, floor feeding, free access stalls etc.) and space allowance (Salak-Johnson et al., 2007; Stewart et al., 2010; Kemp and Soede, 2012; Bench et al., 2013b; Diaz and Boyle, 2014). The main concern about group housing systems is the possibility for aggression between animals in the same group (Bench et al., 2013b), mostly due to competition on food or lying down space (Verdon et al., 2015), or due to hierarchy (Li et al., 2017), that may lead to stress, injuries, and lameness; lameness was reported to be particularly common in large groups housed on a concrete slatted floor (Cador et al., 2014). In regards to group size, some researchers recommended that 3–7 sows per group is the optimal size from the animal welfare perspective (Bracke et al., 2002), while others suggested that there is no tendency for more aggression in large groups (Spooler et al., 2009; Verdon et al., 2015).

In order to improve animal welfare worldwide, with positive support of farmers and producers, the specific welfare friendly housing system should be examined in different environment and conditions without impairing the farm's profit. This may be one reason for the fact that despite the variety of welfare friendly systems available in many countries, including most states in the USA, gestating sows are housed individually in stalls from just after insemination up to few days prior to farrowing. In addition to the possible negative impact of stress on sows' reproduction and production parameters, the public awareness to the welfare of food animals have been dramatically changed in the last years and should be taken into consideration.

The overall objective of this study was to examine group housing management system for sows during gestation as an alternative for individual confinement stalls, and the possible effects on their welfare, production and reproduction performances. Accordingly, the study included three parts with the following specific objectives: (1) to examine parameters of production, reproduction, and welfare of sows housed in groups (either 7 or 30 sows per group) during gestation, as compared to conventional individual stalls; (2) to compare saliva cortisol of pregnant sows throughout gestation, when housed in groups of three different sizes (either 7, 15 or 30 sows per group); and (3) to describe and compare sows' production and reproduction performances at the herd level, before, during and after practically transforming from a management of individual stalls to a group housing system during gestation, in a large commercial swine farm over a six-year period.

## 2. Materials and methods

The study was performed in Lahav Animal Research Institute (LAHAV C.R.O; Kibbutz Lahav, Israel) and the Hebrew University and was ethically approved by the Hebrew University's Institutional Animal Care and Use Committee.

### 2.1. Modifications of the housing system; from individual confinement stalls to a group housing system

Modifications of the housing system were made in order to alter individual confinement stalls into pens that allow a group housing system for sows during gestation (Fig. 1). Changes included removal of partial bars separating individual stalls (Fig. 1A) so that sows had a common space for lying down and to interact while maintaining free access to individual half-open stalls. Each half stall included an electronic automatic feeder and a water source (Fig. 1B–D). Each group housing pen included extra individual half-open stalls to minimize

competition and aggression over food or space (Fig. 1B–D); a pen for 7 sows included 8 individual half-open stalls, a pen for 15 sows included 16 individual half-open stalls, and a pen for 30 sows included 32 individual half-open stalls. Solid commercial swine food (Ambar Feed Institute, Israel) was provided twice a day by the electronic automatic feeders to each sow (either in each of the individual confinement stalls as in Fig. 1A, or in each individual half-open stall in group housing, as in Fig. 1B–D) according to the recommendations of the Nutrient Requirement (NRC) of swine.

### 2.2. Study 1: examination of production, reproduction, and welfare of sows housed in groups (either 7 or 30 sows per group) during gestation, in comparison to conventional individual confinement stalls

#### 2.2.1. Animals and study design

This part of the study was conducted during 2014. It included sows from parity 3 to 8, mixed breed of Landrace, Large-White, Pietrain and Duroc, identified by ear tags. Sows were artificially inseminated with commercial boar semen while in estrus, and were kept in individual insemination stalls for a maximum period of 28 days. Thereafter, sows ( $n = 324$ ) were allocated randomly to either a Large Group of 30 sows per group (LG:  $n = 240$  sows; 8 groups) or a Small Group of 7 sows per group (SG:  $n = 84$  sows; 12 groups). Approximately 4–5 days prior to anticipated farrowing, sows were transferred into individual farrowing crates. As the use of individual confinement stalls during gestation was not allowed according to the Israeli Swine Legislations in 2014, an historic control was selected from the Herd Management Software (Farm®, Agrovision); sows in the control group (IS, Individual stalls;  $n = 324$ ) were matched randomly to each of the sows in the SG and LG, based on parity and parallel insemination date ( $\pm 1$  day) from 2012, when all sows were housed in individual confinement stalls during gestation. All sows included in this part of the study were housed in the same building, received the same commercial swine food (Ambar Feed Institute, Israel) and were managed by the same farm's animal care employees and veterinarian. The farm did not have any genetic selection program for sows and boars, and breeding management as well as medical management were uniformed along 2012–2016. Comparison of farrowing rate of the group housing management was to 1713 control sow cycles available from the Herd Management Software data (parity 3–8; Year 2012). The farm management regarding heat detection, artificial insemination (AI), as well as transfer to farrowing crates was similar during the study.

#### 2.2.2. Assessment of injuries and lameness index (ILI)

The physical condition of individual sows in the SG and LG was assessed every two weeks on a scale from 1 to 5, based on injuries and lameness index (ILI), by two independent observers (a researcher and the head of gestating sows' department); the average score of the two observers was recorded for analysis. ILI was recorded starting from the day the sow was moved from the individual insemination stall to the group pen, until moving out to farrowing crates. The ILI score was based on lameness and injuries, as follow: [1] not injured or lame; [2] minor injury/lameness not interfering with routine life; [3] Injury or lameness that hinder routine life; [4] Major injury or lameness; [5] Severely injured - unable to stand.

#### 2.2.3. Collection of reproduction and production data

Reproduction and production parameters were recorded using the Herd Management Software (Farm®, Agrovision). Dates recorded included: previous farrowing date, insemination date, cycle number (parity), group mixing date after insemination, farrowing and weaning dates, or returning date/culling date (if returned to estrous or culled). Reproduction and production parameters included: litter size (number of total born piglets), number of born alive piglets, number of born dead piglets, gestation length (successful insemination-to-farrowing interval), and cycle length (weaning-to-weaning interval). Farrowing rate

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