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Stocking density: How much?

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Space, the final frontier.

Even a dairy cow dreams of space – to lie down and to eat. She also has specific requirements for space to meet her potential for milk production and reproduction. A measure of the space we provide to dairy cows is stocking density.

Stocking density on the dairy, also known as stocking rate, is the number of animals per unit area in a drylot pen or pasture, the number of animals per free stall in a free stall pen, or the number of feet of bunk space. Stocking density affects a cow's resting time, feed intake, milk production, lameness, reproduction, hygiene, behavior and health. Stocking density measures are also part of animal welfare assessment and auditing guidelines and are important for investigation of herd health and performance concerns.

But do we know how many is too many to have in a pen? In this article I will explore some of the consequences of overcrowding, as well as some of the measures and recommendations for stocking density in different kinds of pens.

Cow comfort and stocking density

One way that stocking density mediates its effects is through cow comfort. There are three indices of cow comfort:

Cow comfort index (CCI): The number of cows lying in a stall divided by total number of cows in contact with a stall (Nelson 1996).

Stall standing index (SSI): The number of cows standing in a stall divided by total number of cows in contact with a stall (Cook et al. 2005).

Stall use index (SUD): The number of



cows lying in a stall divided by the total number of cows in the pen not eating (Overton et al. 2003).

Only the third index of cow comfort looks at the total number of animals that are just standing around. The other two are indicators of the potential for animals to use a stall, or stall comfort. We can use these measures to help us with stall comfort, but some cows may not be able to use the stalls at all because there aren't any left, and none of these indices measures cow comfort in drylot corrals.

The Miner Institute in New York has been conducting a number of prospective studies on stocking density in free stall barns. One looked at the indices of cow comfort noted above and found that maybe the Stall Use Index was a more robust measure when considering stocking density, because as stocking density increased Stall Use Index decreased.

Overcrowding free stalls has an effect on cow behavior. Because of the way we manage cows in groups and perform routines such as feeding at specific times, milking at specific times, etc., cows function as a group

when it comes to resting and eating. It has been reported that at about 120 percent stocking density (120 cows in a pen with 100 free stalls), cows sacrifice feeding time to make up for lost resting time, they spend more time actually standing or waiting in alleys to lie down, and they are unable to recover from resting deprivation once it exceeds two to four hours per day. From one report, every hour lost in resting time results in a loss of 3.7 pounds of milk per cow per day. Certainly the numbers of stalls per cow is important as a measure of stocking density and inadequate stall design or lack of stall comfort will make overcrowding worse.

Milk production

Because of the effects of stocking density on feeding time, it makes sense that milk production will be affected. At the University of Wisconsin the effect of overcrowding close-up free stall pens containing both first-calf heifers and older cows was evaluated. If stocking density was greater than 80 percent, milk yield was reduced for heifers during their first three months in milk following calving. For each 10 percent increase in prefresh stocking density above 80 percent there was a 1.6-pound per day reduction in milk yield for the first-calf heifers. Stocking density affected the low-ranking heifers disproportionately.

Stress and lameness

Overcrowding also increases stress in cattle. In one Virginia study 44 cows were housed together before they were relocated to new free stall pens with four different stocking densities: 0.67, 0.83, 1.0, or 1.17 cows per stall. (K. Pence, MS thesis, Virginia Tech 2005). Cows housed at a stocking

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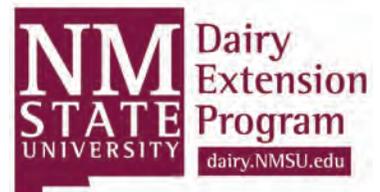
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rate of 1.17 cows per stall had higher plasma cortisol levels (a stress hormone) than did cows housed at a stocking rate of 0.67. Stocking density appeared to affect subordinate or low-ranking cows the most in another study.

With a stocking density of 1 cow per stall, low rank cows spent less time lying and more time standing in free stalls than middle and high-rank cows. By 25 weeks into their lactations, more than 60 percent of the low rank cows had become lame compared to 18 percent of the high rank cows (Galindo and Broom 2000).

Bunk space

Bunk space can also be overcrowded. Because of the way we feed animals (one to two times a day, for example) we need to have most of the cows eating at the same time so that all cows get all the benefits from the balanced ration we want to feed them. If cows eat in “shifts”, ration sorting could become a problem – some cows get the good stuff and some are left with the stemmy hay.

Several investigators have looked at the number of headlocks per cow as a measure of stocking density. In one report, Huzzey and others (2009) showed that as the number of 24-inch headlocks per cow decreased from 1.33 per cow to 1 for every 3 cows, the percentage of cows feeding decreased from 61.3 percent to 28.5 percent, and the percentage of cows just standing around increased from 3.8 percent to 25.6 percent. They also looked at post-and-rail feeding systems and found similar decreases in the percentage cows feeding below 24 inches of bunk space, and reported that subordinate cows are displaced most often at high stocking densities, particularly when using a post-and-rail barrier feeding system.

Most headlocks are made to be 24 inches wide for dairy cattle. However, this might not be adequate for transition cows. Wisconsin investigators have evaluated the

standing time increased as stocking density increased and more cows were standing in the alleyways.

Stocking density and reproduction

In a recent report, Schefers and others (2010) looked at data from scores of dairy farms (mostly Wisconsin and New York but a number of other states were included) in order to develop predictors of conception rate in dairy herds.

Stocking density was found to be a significant predictor of conception rate; as stocking density increased conception rates decreased. For every one percent stocking density increase, conception rate decreased by 0.10 percent. This means that controlling other factors that have an effect on conception, a 20 percent increase in stocking density could shave two percent off your conception rate.

The investigators went on to say that “Overstocking of the breeding pens is often overlooked when considering factors associated with reproductive performance.” Therefore, if you are having a problem with conception rates, maybe include a look at the stocking density in your breeding pens as a possible reason.

Stocking density and weight gain

Even heifers are affected by stocking density. Keys et al. (1978) found that reducing feedbunk space from 32 inches per head to just 11 and 8 inches per head reduced average daily gain and total eating time per day for Holstein heifers.

Drylot pens

Drylot pens represent a large proportion of the animal housing on Western dairies. They can also become overcrowded. Little research has been done with stocking density of drylot corrals on performance of lactating cows, but some recommendations have been reported (600 square feet per cow). Drylot pens require enough space per cow primarily for manure and mud management, in addition to resting space and shade (48 square feet per head) or shelter area. Overcrowding would depend on how much useable space was provided to cows for resting.

Bedded pack

There is little research on optimum stocking density for bedded pack housing, but some recommendations do exist. For pre-fresh and maternity cows bedded packs should provide 120 square feet per

cow minimum (Cook 2010). A stocking rate of about 80 square feet resting space per cow is recommended for lactating groups. Increasing stocking density will typically result in too much moisture in the pack, dirtier cows, and higher somatic cell counts (Kentucky Extension).

Stocking density calculations and recommendations

If you are going to measure stocking density you need to look at all aspects: total area and shade area in the case of drylot pens; the number of stalls for free stall

Table 1.

pen	index	calculation	adult
free stall	animal density per stall	number of animals divided by number of stalls	>1.2
drylot	animal density per 600 sq. ft.	number of animals divided by 600 sq. ft. per pen	>1.2
drylot	animal density per 48 sq. ft. of shade	number of animals divided by 48 sq. ft. of shade	>1.2
all pens	feet of bunk space per head	linear feet of bunk space divided by animals in the pen	24" to 30"

pens; and the bunk space for all pens. Stocking density can be calculated by the number of linear feet of bunk space per cow, number of cows per free stall, or number of cows per drylot or shade area. Table 1 above provides some measures of stocking density and some estimates for what might constitute overcrowding for free stalls as well as drylot pens.

Recommendations for young stock include providing at least 18 inches per head at the feed bunk, 200 square feet in the corral, and 20 square feet of shade per animal.

What's the first step?

We do have some information on the effects of very overcrowded conditions on weight gain in heifers, reproduction, lameness and cow behavior, particularly lying time. We know that all these outcomes are associated with milk production. However, more refined answers as to what new recommendations for stocking density will come from follow-up studies of different stocking densities and their effects on milk production and reproduction.

First, we need to go back to our herds and take a look at each pen for stocking density. Are we over 80 to 100 percent in our transition cow pens? Are lactating pens more than 120 percent overstocked?

Second, stocking density should be one risk factor to consider when trouble-shooting herd problems with milk production, reproductive performance or health issues.

Third, we need to consider all the ways a pen might be overcrowded – at the bunk, in the free stalls, for total area, and for shade or shelter. We likely still have some opportunities to improve the health, welfare and performance of our cows and heifers.

Impact of overcrowding on standing, lying and feeding times by cows.

behavior	stocking density				P-value
	100%	113%	131%	142%	
lying (hours)	12	12	11.7	11.1	0.0006
total standing	12	12	12.3	12.9	0.0007
stall	2.5	2.3	2.2	2.1	0.01
alley	1.7	1.9	2.6	3.1	<0.0001
stall front feet	0.5	0.4	0.3	0.2	0.02
parlor	1.9	1.8	1.8	1.8	0.22
feeding	5.0	4.9	4.8	4.9	0.9

time budgets of transition (close-up and fresh) cows and currently recommend that 30 inches of bunk space per cow be provided in both the close-up and fresh cow pens. This makes sense since heavily pregnant cows in close-up pens are larger.

Overcrowding could occur both with the free stalls and the bunk space in a pen. Hill and others (2009) exposed 92 cows and 44 first-calf heifers to different stocking densities based on restriction of both stalls and headlocks. In a 24-hour period the number of hours spent lying in the stalls decreased as stocking density increased and the total

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