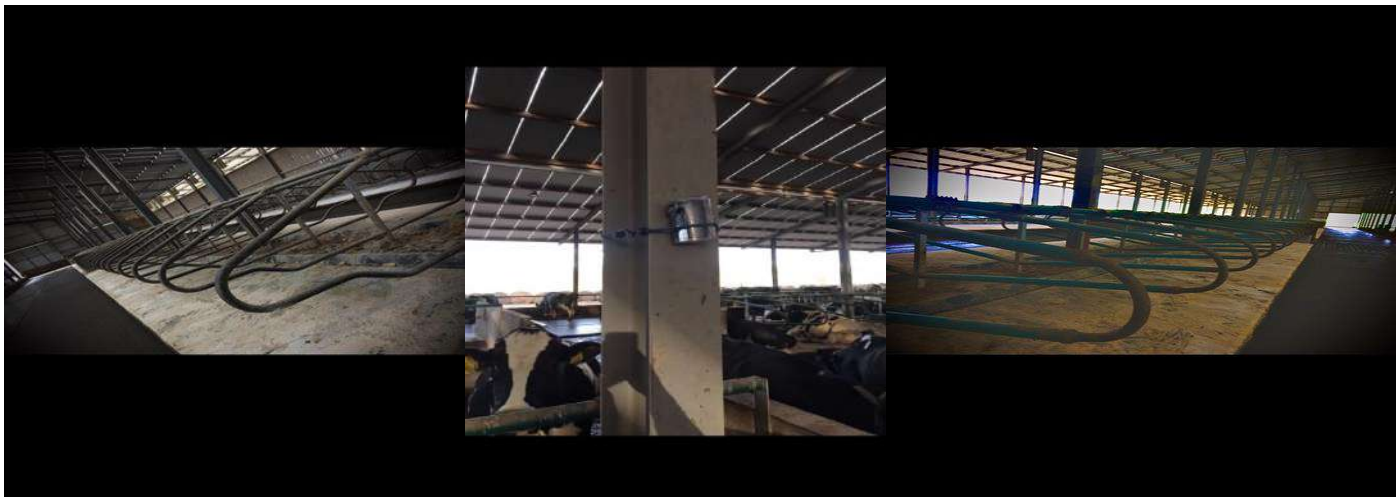
Contrasting the lying down times of cows occupying steal cubicles compared to plastic cubicles.



By

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Abstract

The expansion in the dairy sector in Ireland occurred due to abolition of the milk quotas in April 2015; this brought the opportunity for herd expansions and new dairy farm entrants. Food Harvest 2020 and Food Wise 2025 promoted the expansion in the dairy sector, with targets to boost production by 50% by 2020. Increase in herd sizes and new dairy farms resulted expansion of animal housing mainly cubicle sheds for winter months. Easyfix introduced a flexible plastic range of cubicles in 2014. Cow comfort/welfare were the topics of this research as there was no previous research carried out between steel (rigid) and plastic (flexible). The aim of the research was to observe occupancy rates of each type of cubicle and which was higher. The research site was a shed on an intensive dairy farm, the shed containing both types of cubicles with cows having access to both. A time-lapse camera was set up facing 8 replicates of each type of cubicle for two 24hour periods, the footage was analysed and occupancy times recorded. The plastic (flexible) cubicles had a significantly ($P \leq 0.05$) higher occupancy time during both monitoring periods than the steel (rigid) cubicles. First 24hr ($P=0.045$), second 24hr ($P=0.010$). The average occupancy time of the plastic cubicles was higher on both occasions by 1.19hrs in the first 24hr and 1.41hrs in the second 24hrs compared to the average occupancy time of the steel cubicles. Suggesting that the cows could lie more naturally and less restricted in the plastic cubicles due to the flexibility.

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Introduction

The Food Harvest 2020 report proposes a 50% increase in milk output for the Irish dairy industry using smart green technologies by 2020(DAFM - Food Harvest 2020). Milk quotas in Ireland were abolished in 2015 April 1st for the first time since 1984 this allowed the increase of milk production throughout the country to meet the food wise 2020 proposals.

Expansion of dairy farms comes with increased cow numbers and facilities needed. The main focus in the process of expansion being solely on aspects that are seen to increase profitability instantly such as increasing stock numbers and increase pasture performance. Therefore, it has been advised for investment in housing to centre on low cost capital expenditure (Teagasc.ie, 2011). This is difficult to understand as it has the potential to ignore aspects of the 5 freedoms of a cow if done inappropriately with an insufficient thought on cow welfare and comfort. The 5 freedoms being freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury or disease; freedom to express normal behaviour; and freedom from fear and distress (Jacques Capdeville & Isabelle Veissier, 2010). Overall the cows that are comfortable will have less stress, eat more, less health problems and less injury prone.

The 3 natural behaviours that are the most important to the welfare, health and productivity of cows are feeding (drinking included), resting and rumination (Grant, 2009). A day in the life of a lactating dairy cow broken down to a time budget for each activity (Grant, 2007). The two activities that can take up 60% to 80% of a 24 hour period of the cow's day are resting and feeding times. The cows demonstrate 12 to 14 hours of resting time and 3 to 5 hours of feeding which can include up to 9 to 14 meals per day while ruminating takes from 7

to 10 hours daily. The majority of the ruminating is done while resting and lying down. This times gives an example of the limited number of hours for milking and other management processes which should be carried out as efficiently as possible to allow the cow the optimum time for eating and resting (Grant, 2000).

Stocking densities on Irish farms have significantly increased after the abolition of the milk quotas in 2015; this has a major role in cow comfort also and is very important to have right and adequate facilities. Despite the impact on behaviour there is a clear economic incentive for farmers to overcrowd free stall facilities which are the main type of facilities on Irish farms in this modern time of dairy farming (J. Bewley, R. W. Palmer and D. B. Jackson-Smith, 2001). Research from (Fregonesi et al 2007) showed that when the stocking density of free stall facilities were over 100% lying times were reduced by approximately 2 hours at a stocking rate above 110% and environmental mastitis and aggressive reactions increased. It is a highly variable relationship but overcrowding at the free stalls (cubicles) tends to result in overcrowding at the feed rail. This relationship is strongly dependent on the shed design (Huzzey, DeVries, Valois and von Keyserlingk, 2006).

Beyond the effects on production and all of the mentioned above reduced lying times also has a detrimental effect on several important health related factors such as, the prolonged periods on concrete flooring results in a greater strain on the hoof when the cows are forced to stand for extended period (Dairy-cattle.extension.org, 2020). Cortisol is the molecule produced within a cows blood and milk when stress is inflicted occurring for example when the cow is restricted from lying down or the cubicle is designed inappropriately.

When (Munksgaard and Simonsen, 1996) conducted research between cows that were deprived of lying down time and comfortable cubicle conditions compared to cows that were unrestricted from lying down and had sufficient cubicle conditions, showed an increase in the concentration of cortisol in the blood. A concentration of cortisol like this can be associated

with the suppression of the immune function of the cow's system that will result in the cows being more susceptible to diseases (Munksgaard and Simonsen, 1996).

(Nishida et al., 2004) conducted a study to measure the chronic differences of blood flow to the gravid and non-gravid uterine horns using a transit time ultrasonic flow probe surgically fitted around the uterine of each cow in the research. The results of this research found that significantly more blood flowed to the gravid uterine horn when the cow was lying down compared to when the cows were standing. The more blood flowing while lying down had benefits for foetal growth during the gestation period of the cows. Resting has many benefits for the cow including greater milk synthesis due to a greater blood flow through the udder, increased rumen effectiveness, less stress on the hoof and legs which results in less lameness, less fatigue and stress to the cow and a greater feed intake (Grant, 2009). Each additional one hour of resting time translates into 2 to 3.5 more pounds of milk per cow daily. On this paper a scatter plot showing the relationship between resting times and milk yield in dairy cows had a linear regression displaying the larger the resting time the more milk produced by the cows (Grant, 2004).

Stall comfort is optimum and measurements are very important the width of the cubicles should be installed to suit milking and dry cows with a minimum width of 135cm and the neck rail should be a minimum of 125cm above the lying surface (Teagasc.ie, 2009). Head space is an important feature also as the cow need to lunge forward to get up from a lying down position on the cubicle; the lunge space must be at least 30cm. If the cow finds it difficult to gain access in and out of the cubicle space this will cause stress and lying down times significantly reduced as the cow is unable to lie down replicating its most natural behaviour without stress. Cows should be able to get up the same way in a cubicle that they would outside at pasture (Milkproduction.com. 2007).

Cleanliness is an important part of stall design as this would result in how clean the cows are overall. This would be an indication of cows lying on the concrete rather than the stalls, the stalls being dirty or the design of the cubicle is poor. The wet knee test is used by farmers and consultants by kneeling on the cubicle surface for 10 seconds if the knee is wet proves the cubicle is not clean or dry enough for the cows. The type of bedding in the cubicle is also a big factor on how comfortable the cow will be in it. Poor quality bedding in the cubicles can be noticed from lesions on the cow's body in areas such as their hocks, legs and knees. Cushion surfaces such as sand and cushioned mats are desired by the cows rather than a concrete surface. The best bedding source ideally should conform to the cow's body and reduce pressure points and increase weight distribution and sand provides all of these (Norring et al., 2010).

The research being conducted in this study is to compare cow behaviour and use of flexible plastic and rigid steel cubicles. There is a knowledge gap as there has been little to no research done on this topic regarding cow comfort in relation to lying times as the flexible plastic cubicles are relatively new from Easyfix. The hypothesis of this research is that the cow will favour the plastic cubicles in relation to longer lying times rather than the steal cubicles as the plastic cubicles are more flexible and will create a more comfortable environment. The research will be conducted in a shed with both plastic and steel cubicles available for the cows with the exact same conditions such as feed available and cubicle mattress other than the type cubicle.

Materials and methods

The hypothesis of the experiment is that the plastic flexible cubicles provide the cows with a more comfortable lying down behaviour when compared to the steel rigid cubicles. This will be indicated by increased occupancy and lying down times in the flexible cubicles compared to the rigid cubicles. The subject of this research is cow welfare and cow behaviour.

The experiment was carried out on an intensive dairy farm with 600 dairy during the month of February. On the farm there are two types of cubicle divisions, the Easy Fix flexible cubicle (calm) and the more traditional rigid steel cubicle. The cubicles with the flexible divisions are set at 1100mm centres while the cubicles with the rigid steel divisions are set at 1200mm centres so are 100mm wider. A neck rail to prevent the cows entering too far into the cubicle and having difficulty in getting up is set at 202mm from the heel stone of the cubicle bed. The neck rail on the flexible cubicle is also plastic, 100mm, and flexible while the neck rail on the rigid cubicle is a rigid steel pipe 75mm in diameter.

All cubicles in the shed have the same cubicle bed (mattress) called the Easy Fix Phoenix, which consists of a straight edge cubicle mattress, a natural rubber compound, has a 25mm layer of latex foam is interlocking on two sides with a sloped profile at the rear edge, 500 micron sealed wrapper enclosing 25mm latex foam and properties made up of Foam 50% latex and 50% polyurethane. The dimensions of the mattress are 1800mm long by 1120mm wide × 35mm.

The cubicle shed is a typical layout for dairy farms consisting of rows of cubicles and a feeding passage giving cow's free access to food at all times. The shed used consists of 26 bays and contains 400 cubicles, 220 flexible and 180 steel cubicles. The steel cubicles are situated in the first 9 bays and closest to the milking parlour. The rest of the shed is occupied by the plastic cubicles.

A time lapse camera (Brinno TLC200 Pro HDR (high dynamic range) with features such as image sensors and ultra-big pixel size of 4.2 µm and a CS-mount interface (interchangeable lenses) was used to capture the necessary footage of the cows' behaviour on the occupancy of the different cubicles (Brinno, 2020).

Study site

Sourcing the ideal study sight was the first procedure this was difficult as these sites were limited. The housing unit that had both plastic and steal cubicles that the cows had access to, every other factor had to be the same such as diet, water supply, flooring, cubicle surface and all cows are in the same stage of lactation. The study took place between interface of newly built section which had the flexible cubicles and the older section which had the rigid cubicles. The location of the study was equidistant from drinking water and feeding facilities. The two experimental groups in this experiment were the flexible plastic cubicles and rigid steel cubicles. Each group had 8 replicates of each cubicle. The independent variable of the experiment is the material of the cubicles and the dependent variable is the lying down time of the cows measured by hours.

The camera was mounted on an RSJ support pillar set at 2200mm above ground level and set at a 45^0 at a point where the rigid steel cubicles ended and the flexible plastic cubicles started. For 24 hours the camera was trained on 8 steel cubicles to monitor the behaviour of the cows as regards occupancy of these cubicles over a 48-hour period. Afterwards the camera was taken down and the footage downloaded on my laptop for analysis and briefly checked for recording accuracy and quality.

The camera was returned to the RSJ but trained on the flexible cubicles for a 48-hour table to monitor the behaviour of the cows as regards occupancy of these cubicles. Afterwards the camera was taken down and the footage downloaded on my laptop for analysis and briefly checked for recording accuracy and quality.

Satisfied with the footage taken of the two type of cubicles the camera was taken off site and the data gathered was analysed in depth and transferred into Microsoft Excel work sheet for analysis.

Statistical Analysis

All data was transferred into an SPSS system the particular software used was IBM SPSS software (SPSS Software, 2020).

The descriptive statistics of the two sets of data (the first and second 24 hrs) was done. By observing the descriptive statistics of the two monitoring periods, a T test could not be done as both sets of data were not normally distributed tested with the Kolmogorov-Smirnov test. The variance was not the same in both samples tested by the Levenes test. 2 Mann-Whitney (nonparametric test) were carried out one on each of the monitoring periods, to observe the differences in the median of the two types of cubicles within each monitoring period.

Two box plot graphs were made using SPSS, one for each monitoring period displaying the data of the two types of cubicles and their occupancy times.

Results

In the first 24hr period of monitoring the cows lying down times (hours), there was a significant difference in the median time spent lying down between the two types of cubicles (steel and plastic) U=13, P=.045. With the plastic cubicles having larger lying down times (median= 16.15 hrs, IQ = 1.6 hrs) than the steel cubicles (median= 15.25, IQ= 2.8). Concluding in the first 24hrs period of monitoring the plastic cubicles had a higher occupancy rate and for a longer period than the steel cubicle. The maximum time recorded for the cubicles during this period was steel= 16.5 hrs plastic= 17.3 hrs. The lowest time recorded during this period was steel= 11.5 hrs plastic= 15.3 hrs can be observed on table 1 of the data collected. The range of time recorded during this period of monitoring was larger within the steel data of 5 hrs and a smaller range recorded for the plastic cubicles at 2 hrs. The mean was a larger for the plastic cubicles at 16.15 hrs compared to the steel cubicles at

14.56 hrs, this can be seen in figure 3 in the appendices. From observing figure 1 it can be seen that the steel cubicle lying down times were more variant by the larger error bars compared to the compact error bars of the steel cubicle displaying less variance. The plastic cubicles error bar can be seen in figure 1 to start at the same point the median of the steel cubicles time is, concluding that all of the plastic cubicles times were at the same as and above the median of the steel cubicles.

In the second 24 hr period of monitoring the cows lying down times (hours), there was also a significant difference in the median time spent lying down between the two types of cubicles (steel and plastic) U= 7.5, P= .010. With the plastic cubicles having higher lying down times the same result as the first 24 hrs period (median= 16.10 hrs IQ= .8) than the steel cubicle (median= 14.45 IQ= 1.8). Resulting in the same conclusion as the first 24 hrs period, the second 24 hrs period of monitoring the plastic cubicles had a larger occupancy rate and for longer periods than the steel cubicles. The maximum time recorded for each type of cubicle during this period was steel= 16.10 hrs plastic. The lowest time recorded during the second 24 hr period of monitoring the cows was steel= 12.40 hrs and plastic= 14.50 hrs can be seen in table 1 of the data. The range of the times recorded during this period of monitoring lying down times the steel cubicles again had a larger spread of times at 3.7 hrs. A smaller range recorded than the first 24 hrs. The plastic cubicles range in this period was the exact same as the first 24 hrs period at 2 hrs of a range.

The result of the mean remained the same as the first 24 hrs period as the plastic cubicles had a larger mean of 16.24 hrs compared to the mean of the steel cubicle of 14.43 hrs can be observed on a relative graph on figure 4. From observing figure 2 the graph displays relevantly the same results as the graph in figure 1 of the first 24 hr period, the steel cubicles lying down times were more variable than the plastic cubicle by studying the size of the error bars. The steel cubicles were less variable in the second 24 hrs period than the first 24 hrs

period not by a significant amount. A similar trend can be seen in figure 2 that is in figure 1, the start of the plastic lying down times (error bars) is relatively at the same point the median of the lying down times of the steel cubicles. The compact error bars for the plastic cubicles in figure 2 display the compaction of the lying down times of the cows relatively the same and little variance.

From the data recorded of the two separate 24 hour periods, the results were relatively the same with little difference or variation. All results remained the same just varying in how much more time the plastic cubicles were occupied than the steel cubicles.

Discussion

The overall findings of the research when contrasting the lying down times of cows occupying steel cubicles compared to plastic cubicles. The plastic cubicles obtained significant higher times of occupancy than the steel cubicles during the two monitoring periods of 24hrs. These results give an indication that the plastic cubicles are more cow welfare friendly to the animals and the cows find them more comfortable.

The average lying down times of the both types of cubicles in the first 24hrs were for the flexible plastic 16.15hrs and for the rigid steel 14.56hrs. This shows an additional 1.19hrs lying down time experienced in the plastic cubicles compared to the steel cubicles. The average lying downtimes of the both types of cubicles during the second 24 hrs were similar to the first 24hrs of monitoring indicating the reliability of the data. The average lying down time for the steel cubicles were 14.43hrs and for the plastic the average lying down time was 16.24hrs. These two averages suggesting that on average the plastic cubicles were occupied 1.41hrs more than the steel cubicles throughout the second 24hrs monitoring period. It can be seen on both 24hrs monitoring sessions from figures 1 & 2 that the median point of the steel times was at the starting point of the plastic cubicles times, concluding that only half of the steel cubicles times were in the same range as the plastic cubicle times.

The highest animal welfare standard is always the desire of every farmer and consumer, extra pressure has been placed on this subject due to the incline of veganism and animal rights activists in the past years. The number of US consumers labelling themselves as vegan grew from 1% to 6% between the period of 2014 to 2017 resulting in a 600% increase (GlobalData, 2020). This emphasises that the farmer must provide the 5 freedoms of cattle to obtain a high standard of animal welfare. The 5 freedoms of cattle are as follows, 1: Freedom from thirst, hunger and malnutrition – by ready access to fresh water and a diet to maintain full health and vigour. 2: Freedom from discomfort by providing a suitable environment including shelter and a comfortable resting area. 3: Freedom from pain, injury and disease – by prevention or rapid diagnosis and treatment. 4: Freedom to express normal behaviour by providing sufficient space, proper facilities and company of the animal's own kind. 5: Freedom from fear and distress – by ensuring conditions that avoid mental suffering (Gill,R, 2015). All the above were practiced to a high standard on the farm the research was carried out on. In particular freedom 2 was researched in depth during the monitoring, with neither the steel or plastic cubicles depriving any animals from any of the freedoms. Researching which type of cubicle steel (rigid) or plastic (flexible) gave the optimum comfort measured by lying down times. From observing the results, the plastic cubicles provided a more comfortable and natural lying down position. Evidence supporting this is that the plastic cubicles were occupied on average 1.19hrs more than the steel cubicles in the first monitoring period and 1.41hrs was the average extra time the plastic cubicles were occupied than the steel cubicles in the second monitoring period.

In dairy farming it is essential that the cows are as comfortable as possible for the welfare of the animal and also for the optimum performance production wise. Minimal stress is vital and if this is not achieved cows release hormones such as adrenalin and cortisol. Stress effects productivity during milking times as cows suffer a decrease in yield due to the presence of

adrenaline which interferes with the production of oxytocin. Incomplete let-down of milk and residual in the udder tissue leads to an increased risk of mastitis and raised somatic cell count. (Dairy.ahdb.org.uk. 2020). Milk quality decreases with somatic cell count rising and cases of mastitis on an incline (Munksgaard and Simonsen, 1996). Cortisol supresses the immune system resulting in disastrous effects on the reproductive system. This results in cows not going in calf or delayed return to heat. Poor housing conditions and environmental conditions can have both long term and short term stress, such as overcrowding and inappropriate stall design two factors that contribute to these conditions (Dairy.ahdb.org.uk. 2020). There were no signs of stress when on the research site the cows were very relaxed and content in the surroundings and their indoor housing during the winter months.

There has been a significant amount of research done on cubicle/stall design, the majority of the research being based on the surfaces of the cubicles. The Effects of Three Types of Free-Stall Surfaces on Preferences and Stall Usage by Dairy Cows (Tucker, Weary and Fraser, 2003) is a similar type of research to this project. Measuring the usage of cubicles/stalls with 3 different types of surfaces (sawdust, geotextile mattress and deep bed sand), instead of two types of structure/material of the cubicle. There was an overall preference for the sawdust surface on the cubicle surface ($P \leq 0.05$) (Tucker, Weary and Fraser, 2003). Various other projects sculptured around lying down times include the behaviour of lame and normal dairy cows in cubicles and in a straw yard. The results on this research found both lame and normal cows lying down times were significantly ($P \leq 0.05$) higher in a straw yard compared to cubicles (Singh SS, 1993). Straw is seen as unhygienic and cows are dirtier and more susceptible to bacteria residue in the milk compared to a clean cubicle (Norring, 2011). Overstocking effects on lying down times of cows has been researched also and the results are as expected. There was a significant ($P \leq 0.05$) decrease in lying down times of the cows experiencing overcrowding to the cows not overstocked (Fregonesi, Tucker and Weary,

2007). There is an absence of previous research in relation to this project and previous research using plastic (flexible) and steel (rigid) cubicles together. The reason to an absence of research being carried out on the plastic cubicles as they were only launched in 2014 by Easyfix. Including the calm cubicle used during the research (Easyfix Irl, 2020).

In ideal conditions cows would lie down for approximately 14 hrs within a 24 hours period (Milkproduction.com, 2007). Through research carried out (Jensen et al., 2005) came to the conclusion that a housed dairy cow spends 50-60% of the day lying down and insist in maintaining lying down times between 12 and 13 hrs a day. Productivity of the cow is very important for farmer's income and can be enhanced by maintaining high standards of cow comfort. Following research carried out (Grant, 2015) concluded that every hour extra of resting time transferred to 2 -3.5 pounds of extra milk daily. The reason why this research was undertaken was to provide information and clarity to the farmer of the cow's behaviour between the two different types of cubicles. There is ongoing growth and expansion in the dairy sector and investments in cubicle sheds as a result, decisions on the type of cubicles installed can be made by researching results of experiments like this one.

Conclusion

To conclude the research there was a significant ($P \leq 0.05$) higher occupancy time spent in the plastic (flexible) cubicles compared to the steel (rigid) cubicles on both occasions of the two 24 hour monitoring periods. The plastic cubicle enabling the cow to lie in a more natural behaviour as the cubicle can bend to suit their position compared to rigid steel cubicles. Both cubicles provide excellent cow comfort, evidence of this showing the averages of the occupancy above average (>14hrs).

Further research that should be conducted between these two types of cubicles should take place in a specially designed study site, with one type of each cubicle per cow. A preference

test should be carried out to find out which cubicle design the cows the cows prefer and a number of small groups of cows should be monitored for more reliability. The Effects the types of cubicles have on milk composition example of relevant research would be, the examination of SCC on farms that have changed to flexible cubicles and monitor if there was any effects and to what extent.

Appendices

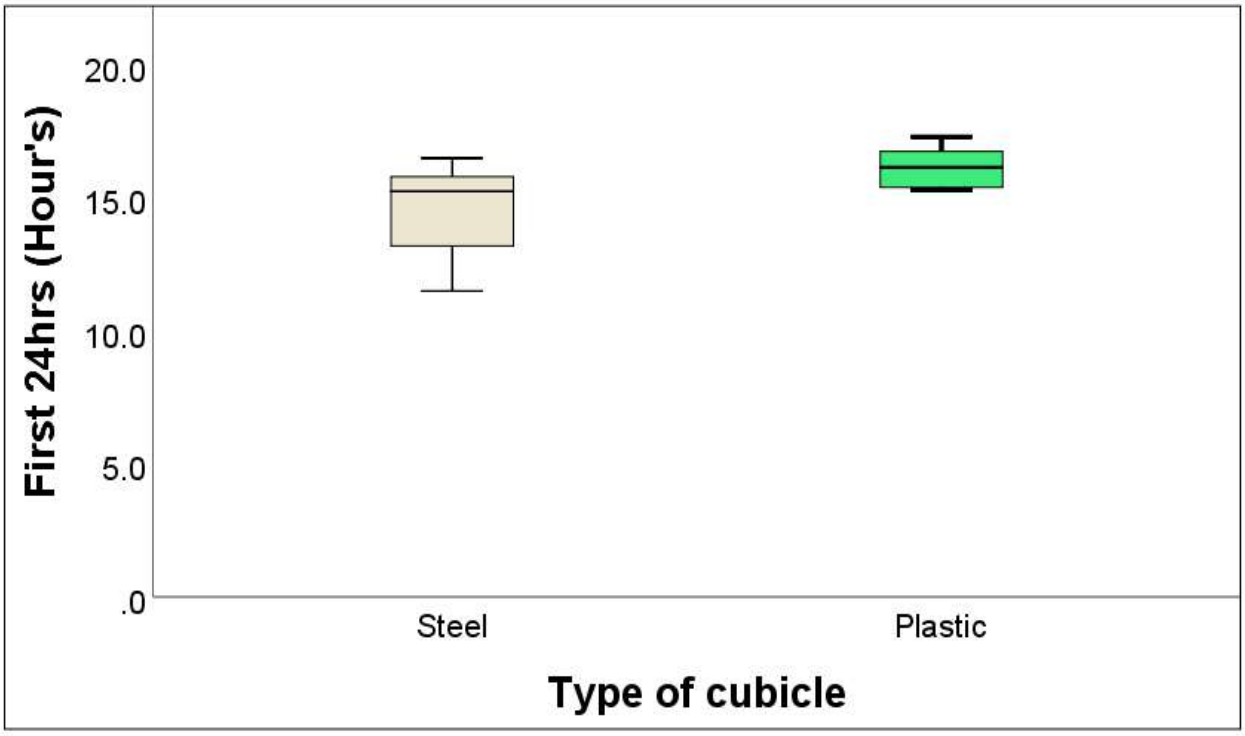

Figure 1: Median and variance of time (hours) that the cows lied down on both steel and plastic cubicles for the first 24hrs period.

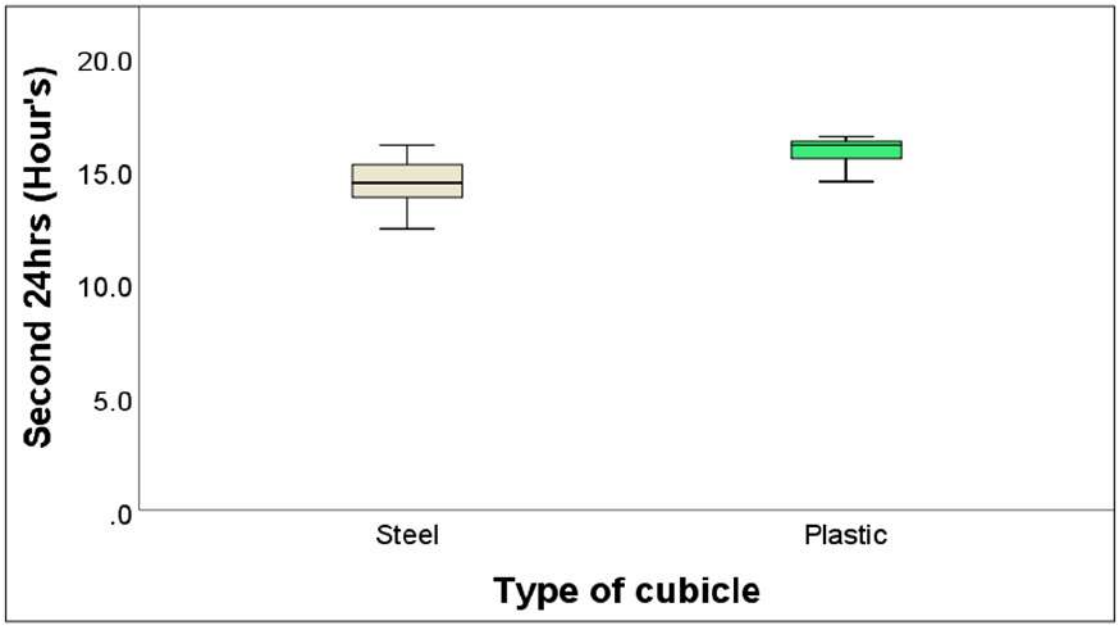

Figure 2: Median and variance of time (hours) that the cows lied down on both steel and plastic cubicles for the second 24hrs period.

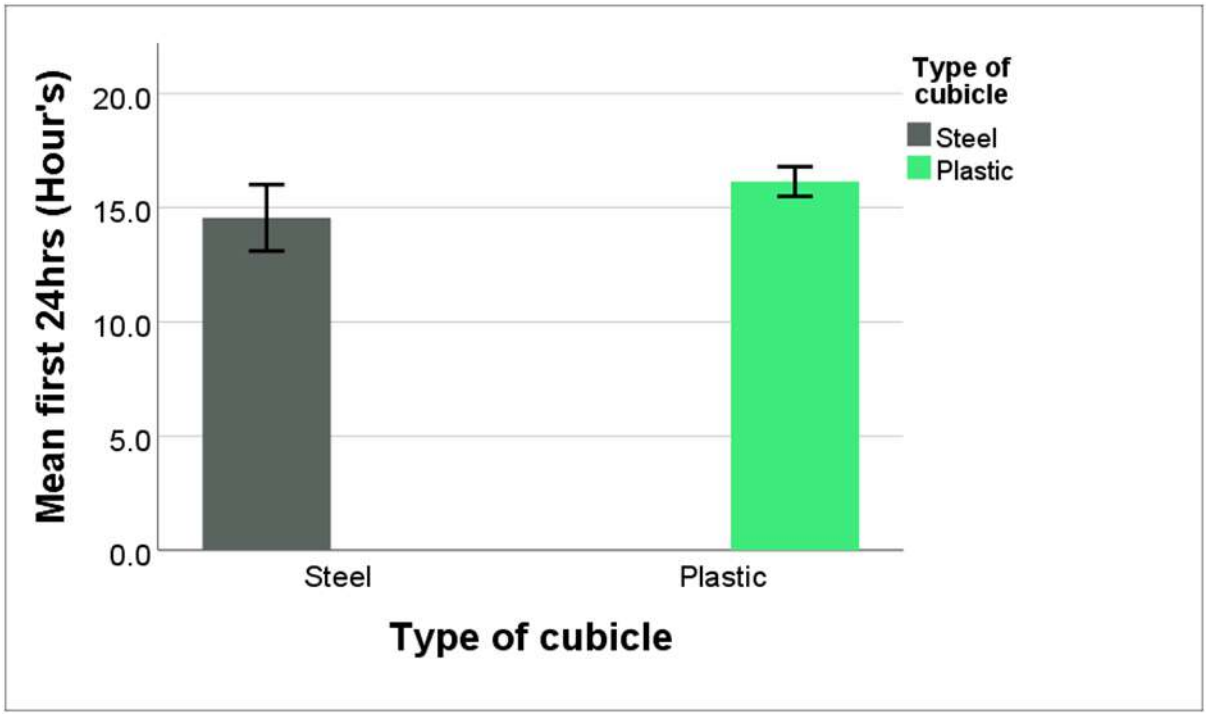

Figure 3: A bar plot comparing the mean lying down times of the steel and plastic cubicles in the first 24 hrs period.

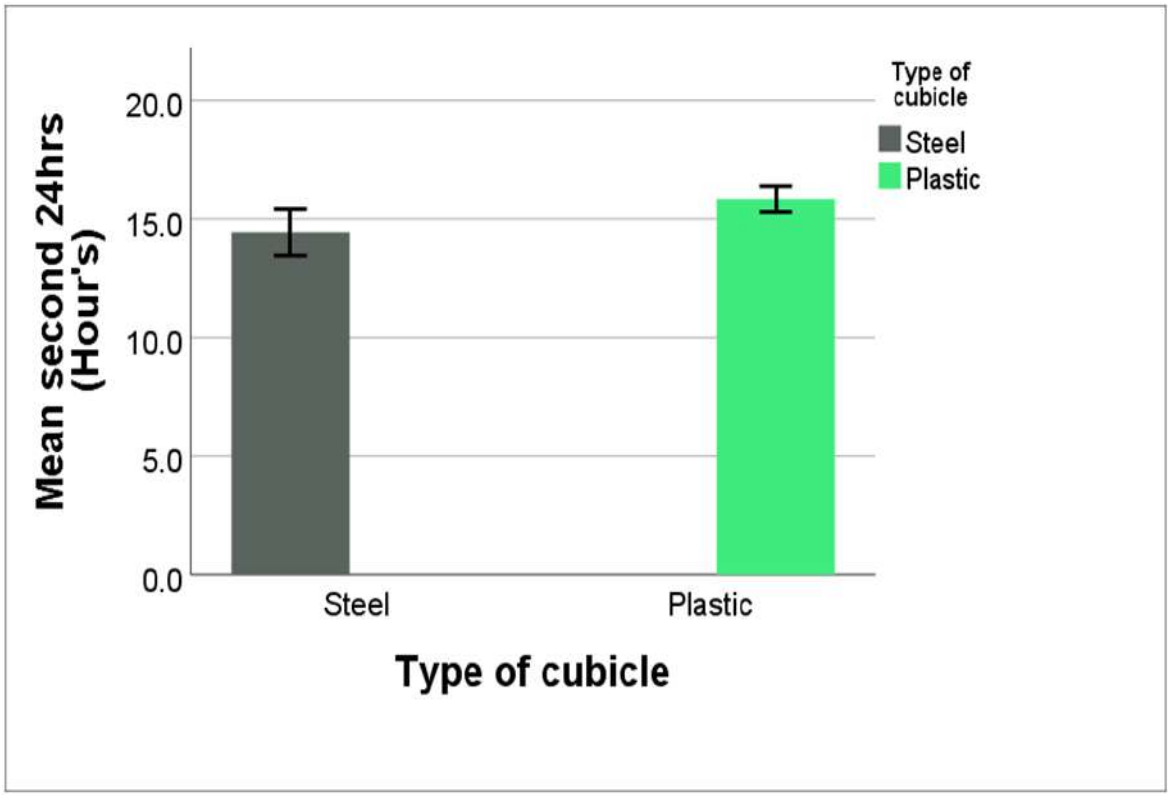

Figure 4: A bar plot comparing the mean lying down times of the steel and plastic cubicles in the second 24hr period.

Figure 5: The time-lapse camera in place to record footage

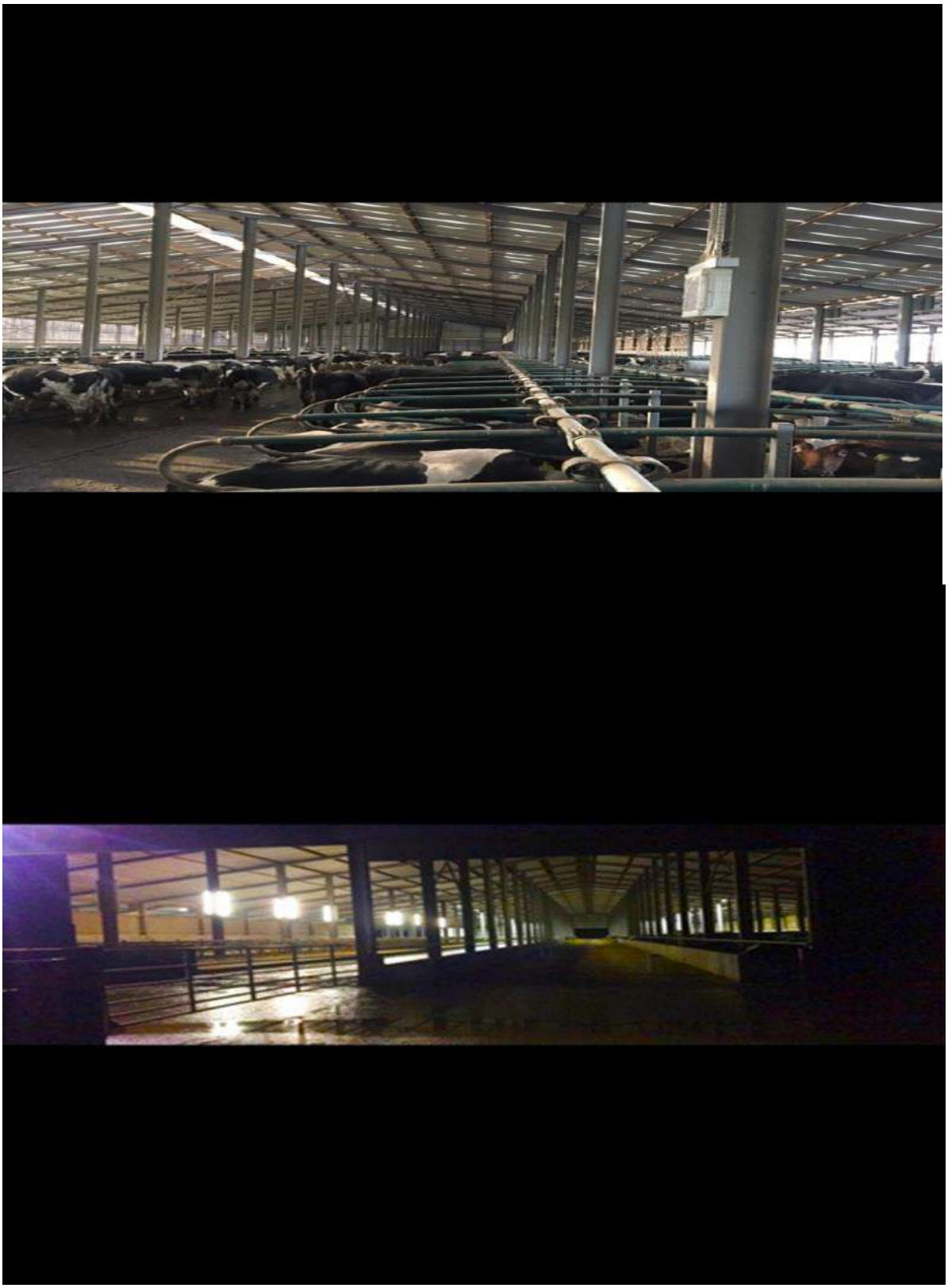

Figure 6&7: Inside and outside the shed, the research was undertaken

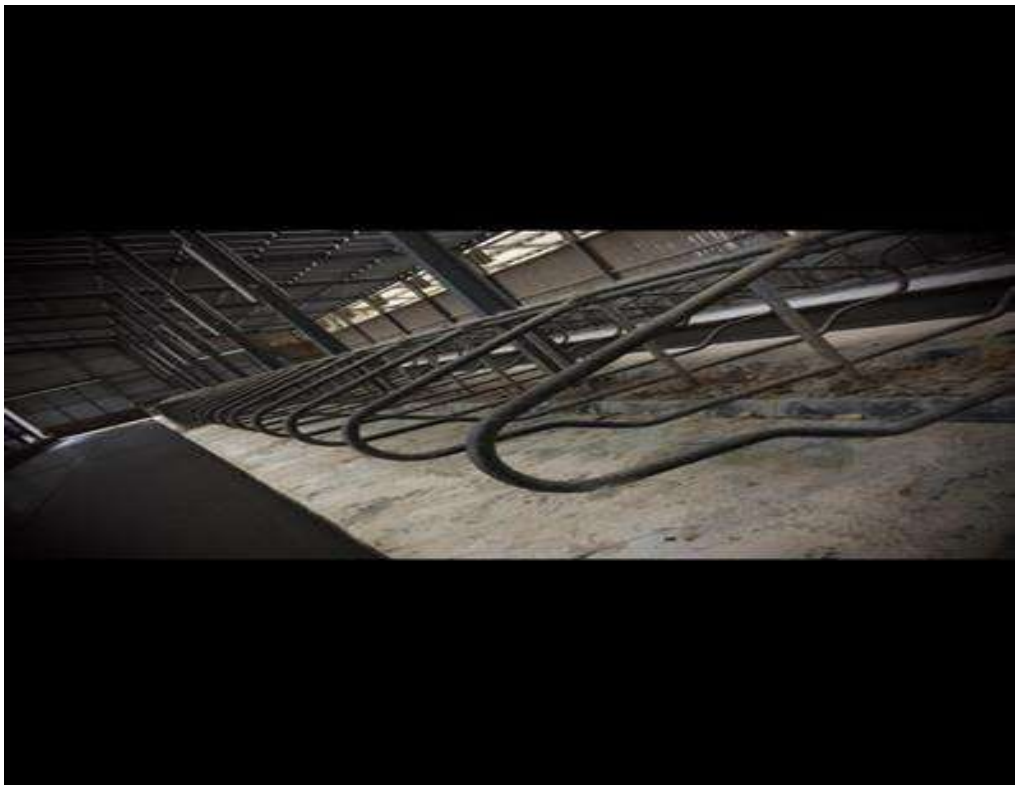

Figure 8: The steel (rigid) cubicles monitored in the research.

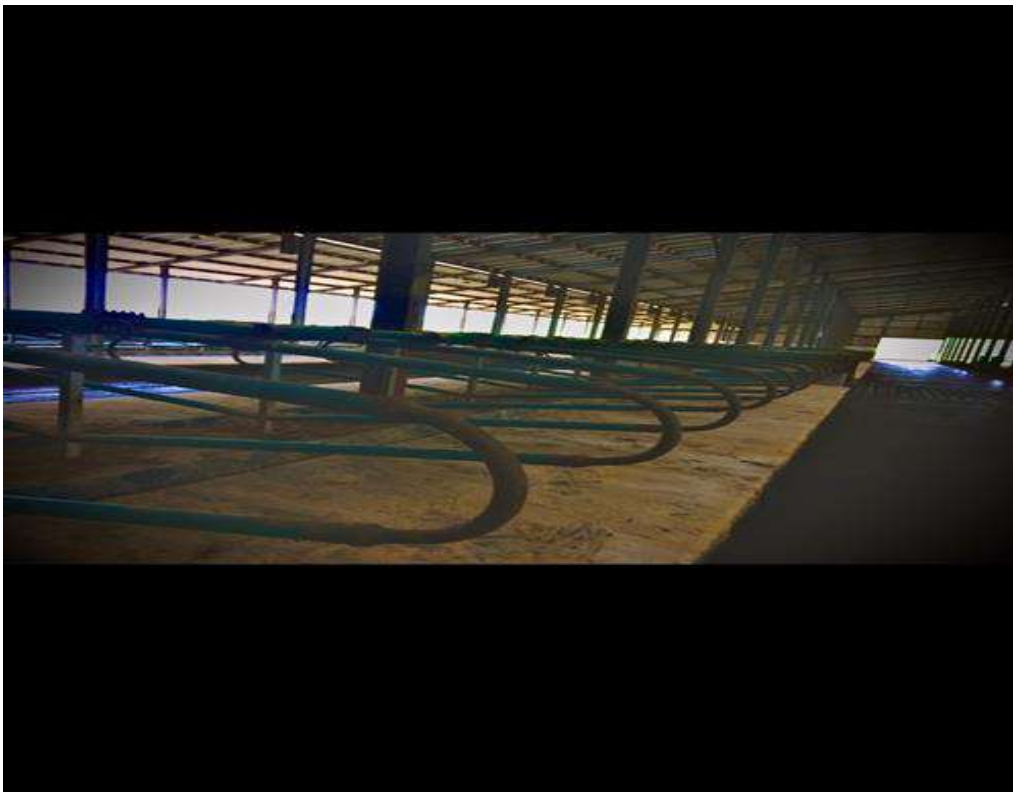

Figure 9: The plastic (flexible) cubicles monitored in the research.

Type of cubicle	First 24hrs	Second 24hrs
Steel	**16.5**	**16.1**
Steel	**15.2**	**14.3**
Steel	**15.4**	**15.5**
Steel	**16.2**	**13.3**
Steel	**13.1**	**14.4**
Steel	**11.5**	**12.4**
Steel	**13.3**	**15**
Steel	**15.3**	**14.5**
Plastic	**15.5**	**16.2**
Plastic	**17.3**	**16.5**
Plastic	**16**	**15.5**
Plastic	**15.3**	**16**
Plastic	**16.3**	**15.5**
Plastic	**16.4**	**14.5**
Plastic	**17.1**	**16.3**
Plastic	**15.3**	**16.2**

Table 1: Displaying the lying down (occupying) times recorded from the 2 monitoring sessions of the steel and plastic cubicles.

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- Host farm & farmer Niall Tallon and staff
- My parents and family

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