Post-Occupation Evaluation Study Report

Centre for Dairy Science Innovation

October 2019

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INTRODUCTION

This report aims to detail the strengths and the weaknesses of the Centre for Dairy Science Innovation development. It will put forward recommendations and highlight best practice and excellence that can be applied to future projects at the University of Nottingham.

OBJECTIVES AND METHODOLOGY

OBJECTIVES OF THIS POST-OCCUPATION EVALUATION

- To bring to light any key issues associated with the building procurement process and management of the project
- To draw out stakeholder feedback concerning the design of the Centre and the experience of those connected with it
- To facilitate a half-day workshop, to discuss and debate the key issues revealed through the primary research
- To analyse all output from the face-to-face depth interviews, telephone interviews and the workshop to provide a summary report with recommendations

SCOPE OF THE STUDY

Building Understanding sought feedback on the following aspects of the Centre for Dairy Science Innovation development:

- Overall satisfaction with the new facility
- Design
- Construction
- Security and biosecurity
- Accessibility
- Lighting conditions: natural and artificial
- Environmental conditions for cattle
- Data connectivity
- Operations and facilities issues

STUDY PARTICIPANTS AND METHODOLOGIES

Building Understanding conducted face-to-face interviews and telephone interviews. Questionnaires were prepared in order to canvas feedback from respondents drawn from the following categories:

- The designer
- The main contractor and one subcontractor
- Key members of the academic departments connected with the Centre
- The dairy manager
- Members of the Estates team
- The project manager

Face-to-face depth interviews

The study included depth face-to-face interviews of approximately one hour's duration with the following stakeholder organisations:

- The capital projects manager
- The architect

- The dairy manager
- One member of the academic team connected with the Centre

Telephone interviews

In addition, telephone interviews were conducted with the following individuals:

Estates Office staff

- Development and Sustainability Director

Contractors

- Two members of the main contractor team
- One subcontractor

Key stakeholders

- Four representatives from the Schools of Veterinary Medicine and Biosciences

The workshop

On 25th September 2019, a workshop took place involving 11 attendees from the various stakeholder groups. The workshop objectives were to:

- Discuss and debate the findings of the primary research
- Generate recommendations to be applied to future projects commissioned by the University of Nottingham
- Highlight nuggets of best practice and excellence revealed in the project that can be adopted and applied elsewhere.

The workshop commenced with a presentation, by Building Understanding, of the findings of the primary research. Attendees were then divided into breakout groups, with each group charged with assigning recommendations to specific points of feedback.

SAMPLE SIZES

It is important to emphasise that the quantitative statistics in this report are based on very small samples. A total of 12 respondents were approached and feedback was received from them all.

QUALITATIVE FEEDBACK

Quantitative satisfaction ratings were collected during the face-to-face and telephone interviews. Respondents were asked to rate their satisfaction with various aspects of the project on a scale of ‘zero’ to ‘ten’, where ‘one’ represents ‘very poor’ and ‘ten’ represents ‘excellent’.

Bar charts displaying the percentage split by rating are shown in the relevant areas of the report. It is very important to emphasise that these quantitative results are drawn from very small samples and are therefore not statistically significant. Some respondents were only involved with specific aspects of the work and so their responses are limited to only that

area. However, these results show at a glance the range of levels of satisfaction with the CDSI project, with scores ranging from ‘four’ to ‘ten’.

PROJECT DATA

Name of facility:	**Centre Dairy Science and Innovation**
Location:	Sutton Bonington Campus
Gross area:	8000m^2
Number of storeys:	One
Users of the facility:	• Staff and students from the Schools of Veterinary and Biosciences • Cattle • Dairy staff
Room types:	Cowsheds, containment level 2 research facility, visitor centre and office
Start on site:	February, 2016
Date completed:	December, 2017
Period on site:	21 Months
Gross construction cost:	£4.2m +VAT
Funding:	Innovate UK
Contract type:	Standard Building Contract Excluding Quantities

PROJECT BACKGROUND

The Centre for Dairy Science Innovation (CDSI) was opened in December 2017 and forms part of the national Centre for Innovation and Excellence in Livestock (CIEL). The University of Nottingham's Sutton Bonington campus now hosts the UK's principal dairy research site, as one of four UK centres of agricultural innovation. The Centre was created with funding from Innovate UK, matched with funding from the University of Nottingham.

The impetus for the project was the lack of infrastructure and research capacity to conduct the quality and quantity of dairy science required by industry and the government. [Exec Paper] Coupled with this, the Schools of Veterinary Medicine and Biosciences were keen to increase the amount of trial work that could be done at the farm.

The site now incorporates:

- Nutrition Barn - allowing automated feeding and precision nutrition for individual milking cows
- Flexible Barn - this globally unique facility allows all aspects of the environment to be rearranged to allow unprecedented experimental comparisons of the impacts of environment on physiology, health, welfare and productivity
- Barn 2 - a containment level 2 research facility (Cat 2) capable of holding a small number of cows for detailed research studies.

Key features of the CDSI are:

- The cows are now on sand bedding, which is a key improvement in cow welfare. It is more supportive, cooler, and harbours less bacteria than other bedding types
- Robots operate at ground level, pushing slurry through gaps in the slatted floor and into the underground slurry scraper system, making it a clean environment for the cows to live in
- The roof pitch is 22.5 degrees as opposed to the usual pitch of 15 degrees for farm buildings, specifically designed to allow optimum natural ventilation
- 100 cows can be fed individually.

THE BIG PICTURE

Overall, the development of the CDSI has been a great success and it was clear from speaking to those connected with the Centre, how proud they are of this world-class facility. The project set out to create a world-leading facility and it was acknowledged by respondents that this objective had been achieved. For the key members of the project team, this project fulfilled the original vision, but for some, the vision has been exceeded.

Testament to the success of this project by industry standards are also the awards the facility has attracted: CREAM and RIDBA awards and a nomination for a RICS award for Innovation.

The Centre was designed to maximise cow welfare. Changes to the roof pitch, from the usual 15 degrees to 22.5 degrees, has meant that the buildings are well ventilated, light and airy. This, combined with automated side curtains which are controlled by meteorological sensors, means the temperature in the space is kept as static as possible. Those connected with the working farm report these features have significantly improved conditions for cows, and these are best illustrated by the marked improvements in the health and productivity of the herd. Average milk yields have increased from 31 to 42 litres per day and cow visits to the automated milking system have also increased. The fertility of the herd has increased, as has the cows' overall health.

One of the most notable features of this project was the extremely swift mobilisation. The team had six months in which to design, get planning for the building and spend £1.8m. While this was a challenging deadline, it was also a key strength of this project. It meant that decisions were made quickly, both within the University and among suppliers, and that key stakeholders had no option but to work together collaboratively and openly to use the budget available to ensure the project succeeded.

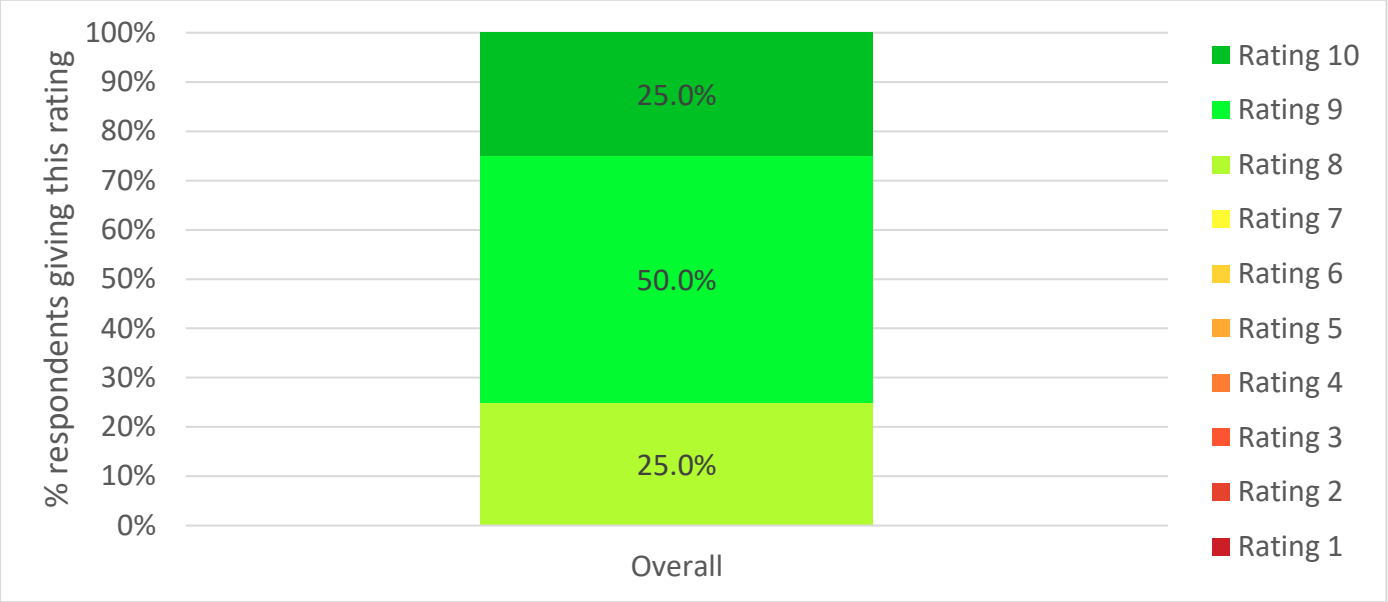
With the development taking place on a working farm, it was vital that any work didn't affect existing operations, and this was achieved with minimal disruption being reported.

As well as the key stakeholders being pleased with the overall outcome of the project, respondents noted how satisfied the funders were and, subsequently, how many visitors had come to the Centre: "Even people who have known the industry for a long time are fairly 'blown away' by it."

While the building itself has been a great success, a key aim of the project was to increase capacity for research activity. With research funding levels not as high as had been anticipated, this has had a knock-on effect operationally and financially on the Centre. Another longer-term objective was to increase the ability to attract the best academic staff. However, attendees at the workshop felt it was too early to demonstrate this as budgetary constraints had reduced the ability of the University to recruit new staff. Coupled with this, the Barn 2 research facility is yet to be utilised.

All respondents were satisfied with the Centre, rating it as an 'eight' or above, and 25% were 'totally satisfied'.

Fig 1.0 Overall satisfaction with the CDSI



QUALITATIVE FEEDBACK - THE DESIGN AND THE CONSTRUCTION PHASE

FEEDBACK RELATING TO THE BUDGET, OPERATIONAL AND CAPITAL COST

Capital outlay

The final capital outlay for this project was £6.2m, within 5% of the original budget. The stakeholders agreed that they were very satisfied with what was achieved within the budget and that it was 'good value'.

Operational costs

For a number of respondents, among the key issues that hadn't been addressed in advance of the project going ahead were those that doubling the size of the herd would bring in terms of the increased land required for forage and for disposing of slurry, as well as extra staff needed to manage more cows. According to one respondent: "That has put pressure on the entire farm." "The operational side, if I'm honest, I don't think there was a robust enough operational plan put in place, so we have had to develop that as we've gone along since the opening of the facility."

The workshop attendees also questioned whether the costs of running the high-spec new facilities were fully assessed during the research phase of the project, when comparable facilities were visited. While there are lots of benefits to operating the new facility, maintenance costs are high, such as for maintaining the scrapers, pumps and purchasing sand. It was agreed that, while the system is much more efficient to operate, replacing machinery is expensive. An example of this was that six months into the project the scrapers required recalibration.

Due to the low price of milk and the high costs of running a Home Office licenced facility, the farm remains in deficit. The two Schools pay a service level agreement (SLA), but it isn't enough to cover the difference. The farm also receives 3% of each trial that comes in, however, there hasn't been enough trial work. A better model, according to this respondent, would be for the Schools to pay a larger SLA up front, which would be reduced should trial work come in.

One respondent commented: "It operates efficiently, yes. Does it meet the University's targets for the cost of the facility, probably no, but the budgets keep getting cut…"

While maintenance costs were calculated based on the number of cows, it was agreed in the workshop that maintenance costs should have been considered from additional perspectives, such as area. Wider consultation beyond the immediate focus of the project would have been a benefit, in order to ensure all issues addressed, such as the increased demand for forage.

Changes to scope in response to budgetary constraints

While it was clear that there had been some changes required as a result of budgetary constraints, in the main, this had not greatly impacted respondents' overall satisfaction with the finished project.

For the Capital Projects Manager, the budget had been challenging because it was clear that, for what the academic team wanted to achieve, the budget wasn't sufficient. Making decisions in these areas was particularly difficult as it was such a specialist area, outside of their area of expertise. There are areas, in retrospect, where it was felt that quality could have been improved, such as the reception and the office areas, the latter being seen to have been "shoved-in a little bit". Plans for more extensive walkways also had to be shelved due to budget constraints. While respondents at the workshop explained that they understood such cuts were necessary in order for the project to come in on budget, the reduction in the walkways and the reduced reception area were a 'significant reduction' to the quality of the visitor experience and improvements on the old facility, in this regard, hadn't gone far enough.

Operationally, some of the decisions have had a long-term impact on the costs of running the Centre. For example, putting resin across all of the floors would have improved the ease of cleaning. "That has an ongoing cost to that in that it takes someone an hour longer each day to clean up because the flooring isn't right. The cost of that over the lifetime of the building is very high but we still had to hit a budget, so we had to manage that." In addition, a high-spec floor in the scraping channels would have reduced wear and tear. Costs of wildlife-proofing the site should have also been incorporated into the budget, as this, as well as enhanced access routes, have had to be added following completion. One respondent noted: "The scope of the project should have been broader to avoid costs later on."

It is in the Nutrition Barn where the cuts are felt most keenly by one respondent. Due to the fact that the shed had to be built ten feet narrower than originally envisaged, the planned central passageway where the electronic feed bins would be located had to be removed. This means that the specialist feed bins are used for all feeding, they are more time consuming to fill and vulnerable to damage. The monorail feed system can no longer be filled up in one go and a facility to be able to feed young heifers individually was also removed from the budget early in the process. This was seen as a 'major omission' by one respondent and it was acknowledged in the workshop that this change has significantly increased operating costs. However, this individual still felt the Centre was a 'superb facility'.

A power supply for the rapid and easy washing down the feeding system was omitted from the project scope but, as a showcase building, Centre staff need to keep on top of the cleaning to ensure that the place looks its best.

One academic commented, however, that the integrity of the Centre was maintained during budget decisions. He said: "Some things we wanted in the design like the cow comfort and the space, we designed the concept and they did the logistics and they absolutely listened. They never said, 'No it's too expensive, we're going to cut your space down'. They said; 'It's too expensive, we're going to cut the reception down'. The red lines, they adhered to, which is one of the reasons it's so good. The novelty part of the building was kept.'

Recommendations:

- When visiting other facilities abroad, request data regarding their lifetime and operating costs, to feed into any business plan
- Endeavour to obtain better estimates for costs of labour and machinery
- Factor in the increased volume of machinery and larger amount of maintenance cost
- Consider how best to forecast maintenance budget increases. (This was done by cow, but it may have also been helpful to have done the calculations by area).

FEEDBACK RELATED TO THE BUSINESS CASE FOR THE CENTRE

During the workshop, respondents discussed the development of the business case for the Centre. Completed before the development commenced, predictions around increases in research funding were based upon previous performance and assumptions about future opportunities. These were considered to be “at the top end of stretch”. Checks and balances were in place, with plans needing to go through Heads of School, Finance Office and Procurement, but this process was accelerated to meet the deadline.

Key members of the School were also integral to the business case so, going forward, buy-in from the School, in terms of who has overall responsibility for the project, should be considered. In addition, the team would welcome key members of staff to be appointed with the specific remit of attracting significant funding for the Centre, and in turn research posts to run projects.

The respondents explained that they would welcome the chance to now sit down with the University’s managers to discuss the facilities available at the CDSI for a certain amount of research, whether the University is happy for that to go ahead, and to discuss what the limiting factors might be.

One workshop attendee suggested that the University should consider appointing a Business Development Director to focus on ‘selling’ the facility and bringing research grants in to the CDSI.

Recommendations:

- For future projects, ensure closer involvement of the Schools in project business plans
- Ensure buy-in from senior managers to the business plan, so if key stakeholders leave the University, knowledge is not lost
- A meeting needs to be arranged across University departments, to explore the facilities available for research, and any limiting factors that would affect this
- Consider the possibility of involving other PIs (Principle Investigators) to win grants for research work at the CDSI
- Consider the possibility of appointing a Business Development Director to focus on bringing research grants into the CDSI
- Think about pulling together a strategy for securing the amount of research funding required.

Feedback related to the Procurement Process and the Drawdown of Funds

The University of Nottingham was successful in applying for funding from Innovate UK, which was keen to fund large projects that could be used to increase the capacity for UK research within agriculture. This project makes the University part of the Centre for Innovative Excellence in Livestock (CIEL) which is a national group made up of several universities.

Funding of £3m was awarded by Innovate and this was match-funded by the University. However, funding was conditional on £1.8m of the spend being made by March 2017, giving only six months to complete this. Given the need to spend so heavily in the front part of the project, there wasn't enough time to tender for the full building, so this was split into two packages of work: ground works and frame in the first package and the fit-out in the second. Having to split the project into two blocks: phase one and two, did present challenges for the project team and restricted decisions in some respects.

The decision to split the project into two phases meant that equipment was purchased up front. Due to the highly specialised nature of this development, the design team was selected in a non-standard way with the University appointing the designers of the existing dairy, which was completed in 2003. Designs for the buildings also needed to be made around equipment that had already been purchased and yet was fundamental to the building. While the tight timeframe did dissuade some suppliers from tendering, according to one respondent the best suppliers in the field did tender.

While acknowledging that this was a 'massive learning curve' for their teams, the University's procurement team was singled out for praise for helping the academic team to navigate through the process at such a pace. One academic respondent noted; "Nottingham impressed everyone by how efficient they were at getting all of the bids and invoices." Another noted how the University 'found a different gear' in order to make the project happen. By handling the funding in a decisive and timely way, it gave academic respondents the confidence that similar projects could be handled as well in the future.

The main contractor also didn't appear concerned by the speed at which the project proceeded, noting that while mobilisation was quick, there was time for them to prepare.

Feedback related to the design and layout

The design

"It does do what we said it was going to do. It's increased yield without changing nutrition, which is only down to the buildings. It's very rewarding."

The CDSI was designed to exceed current industry standards in order to demonstrate how innovative design, combined with the best practices, could improve yield, increase productivity and provide a suitable arena for cutting edge research. Much research was conducted both by the dairy manager and the architect during the design phase, in order to draw on experience from farms both in the UK and abroad. "It's all down to research. Being given that opportunity by the University to look at other ways it's been done…has been the crux of it."

The buildings were designed to provide optimum levels of natural ventilation, keeping cow comfort as the central priority. The 22.5 degree roof pitches as opposed to the usual 15 degrees seen in farm buildings promote natural stack effect air circulation and air inlets. Automated side curtains are controlled by meteorological sensors which means that the building adapts automatically to changes in weather.

Technically, the team had never completed a project like this before. The slurry handling and below-ground scrapers were the first of their kind in the UK. Sand bedding is relatively new and combining it with the underground scrapers presented some challenges to maintenance. The slurry separation system, which removes sand from the extracted water, is also unique. There is pride around the key features of the main cow sheds. and all have been put in place in order to provide maximum cow welfare standards. Bringing everything together was the innovation here.

It is clear that the buildings that make up the CDSI have met the brief and in some respects exceeded expectations. The design has been crucial to its success and according to respondents has had a significant impact on the welfare of the cows housed in the building. The cows have increased yield by 2000 litres per head per year, with no changes in feeding. This has been attributed purely to the improvement in environmental conditions. The dairy manager noted: “In the timescale, there is hardly anything I would change.”

Building types

The main cowsheds are almost uniformly positively received. One academic commented: “The main buildings we now have surpass the original vision…the improvements to the design we have made along the way surpass and work even better than we thought.” The light, open and airy sheds have given the cows a good environment in which to live. One respondent challenged the view that cows would prefer to be outside compared to this shed: “20 or 30 out of 10! Those cows don’t know whether they are inside or outside. They know they have comfy bed and enough space to loaf, so they won’t get bullied. If you have cramped space and tight corners you can guarantee that cow will bully others. That space allows the cows to move away.”

The reception/meeting area was the area of the CDSI where those involved in the design accepted that compromise needed to be made. A number of respondents noted that they would have welcomed a larger space here.

The calf and rearing sheds do have the 22.5-degree roof pitch and so do ventilate better than the old sheds. However, it is felt this is one area where time, and to some extent budget, didn’t allow all of the improvements that would have benefitted the environment for the younger animals. Drainage was a particular concern for workshop attendees, with blocked drains regularly needing to be cleared by hand. A number of respondents feel that the buildings simply replicated what was already there, repeating the same issues as the previous sheds. One academic respondent noted: “We had to produce an older cow facility for the research side and therefore you need a youngstock facility. It was about making do. But when you have a lovely new facility you start to realise that making do isn’t so good.” Workshop attendees agreed that the input and consultation of expertise at the correct stage of this project could have addressed issues experienced with the calf shed.

Barn 2

The Barn 2 research facility building, a key facility for the Schools, enables research to be conducted on small groups of cows. This facility has yet to be used. There were some negative implications attached to what was actually requested. An example of this was the air opening cladding which was requested and yet unexpectedly resulted in dust entering the building.

A number of key members of the project team feel that there was a lack of clarity and engagement from the end users around exact requirements for this building. The snags need resolving and cows need to be 'run through it' before the Home Office will designate it for use. Workshop attendees agreed that barriers around budget, expertise and time have prevented this moving forward. It was felt that involvement from key personnel on the School of Veterinary Medicine could help this to progress.

Recommendations:

- The University to explore the barriers to commissioning Barn 2 with the School of Veterinary Medicine, possibly involving the Head of Operations for the School of Veterinary Medicine
- Going forward, ensure that relevant experts and key stakeholders are consulted fully on key elements of the project.

Lessons to be applied to the Calf Shed project

In the workshop, some lessons learnt from the CDSI which could be usefully applied to the Calf Shed project were discussed. One key piece of learning was to involve in the design an expert, such as the Professor of Ruminant Nutrition, from the start. Incorporating passageways wide enough to fit the calf feeders, rather than retro-designing, was suggested. The importance of involving and inviting input from all potential users at the outset was considered to be very important.

A need for local storage for researchers' kit was identified.

Recommendations:

- Involve experts in the design from the outset
- Consult all the potential users
- Look at incorporating local storage for research equipment
- Involve the Home Office early in the process, if required.

FEEDBACK RELATING TO RELATIONSHIPS, COMMUNICATION AND COLLABORATION

Relationships

"Yes, definitely, what made it good was that everyone was an expert in their field. That helped."

Respondents were ‘mostly satisfied’ with relationships built between the University and the extended team, with all but one of the respondents rating this as an ‘eight’ or above. One respondent was ‘just satisfied’, however two were ‘totally satisfied’.

Relationships between the contractor, the designer and the University were viewed extremely positively, and the experience of both the contractor and the architect within the sector was highly valued. One respondent called the relationship “close knit”. This was particularly crucial in that the build was conducted around a working farm. One respondent noted how open and collaborative the relationships are: “It’s trust, it’s a team and we have a good working relationship. We have a laugh together and we know we have to get the job in on budget and on time. We work well…we talk to each other.”

In particular, the designer valued the autonomy they had been given by the University, calling them, “the perfect clients for me”. The University afforded the designers “the chance to do what you are good at”. Testament to the success of this project in terms of working relationships is that both companies have been selected to work on the subsequent calf housing project.

Relationships between the project team and the School of Veterinary Medicine were seen as positive, but there was seen to be less engagement from the School of Biosciences. For the architect, it wasn’t as easy to collaborate with the academic members of the team, just because areas of speciality differed to such a great extent. However, he feels: “we managed that 99% of the time.” One respondent feels “just satisfied” with relationships, saying that, at times, there was a lack of openness and collaboration and “people protecting their own patch”.

More widespread collaboration between schools at Sutton Bonington was one of the wider original strategic objectives set out for this project, and the key stakeholders feel that this has been achieved with the two Schools working more closely together as a result of the development.

Collaboration within the wider team

“I thought there was some really excellent teamwork and collaboration on the project.”

This project saw some good collaboration between key stakeholders and there was a high level of satisfaction with how the project allowed different partners to collaborate. At the heart of this project was the coming together of two schools, Veterinary Medicine and Biosciences, to put together the initial bid to apply for funding to build the CDSI.

One contractor feels that this was the best relationship they have experienced on a project of this type. They said that the academic members of the team were actively engaged with the project and took on board suggestions they made. However, another contractor respondent did feel that some elements of the process were challenging in terms of the transition from plans into the build.

University processes and good project management helped facilitate this collaborative approach, which was welcomed by key members of the team. In particular, the capital projects manager was singled out for praise for his management of the process and attention to detail.

One academic noted how positive this process had been in terms of different areas of the University working together and getting to understand more about each other's roles. Farm staff, academics and Estates had worked together to determine the spec of the build and reduce costs if necessary. This level of compromise was seen as essential in order to secure the funding.

However, for one respondent, collaboration was rated at 'just satisfied'. This was because they feel that the time pressures meant that they were unable to consult as fully and in as much depth as they would have liked on the exact requirements for each academic function. They also feel that some decisions were made which were focused on the commercial aspect of the dairy, rather than the research side.

Communication

Respondents were all satisfied to some extent with communication on this project. Seven of the nine respondents asked this question rated it as 'eight' or above, 'mostly satisfied', and two as 'seven': 'just satisfied'.

There was a sense that everyone was working towards the same end and the time pressure, particularly at the start of the project, meant that communication of decisions needed to be swift or there was a risk losing the funding. Key members of the project team made themselves available and were open, clear and responsive.

This open communication was particularly valuable in terms of the relationship between the contractor and the University with regards to budgets during the early part of the programme: "Yes, we had an open dialogue with the contractor. We had to from a cost point of view because it wasn't the usual, 'tell us what work you've done and we'll tell you what it's worth', it was a case of saying, 'you need to hit this amount of work'. And we said, 'we will assist you in any way.' Because they had to get a lot of money out of the door very quickly, we did two-weekly evaluations throughout the project."

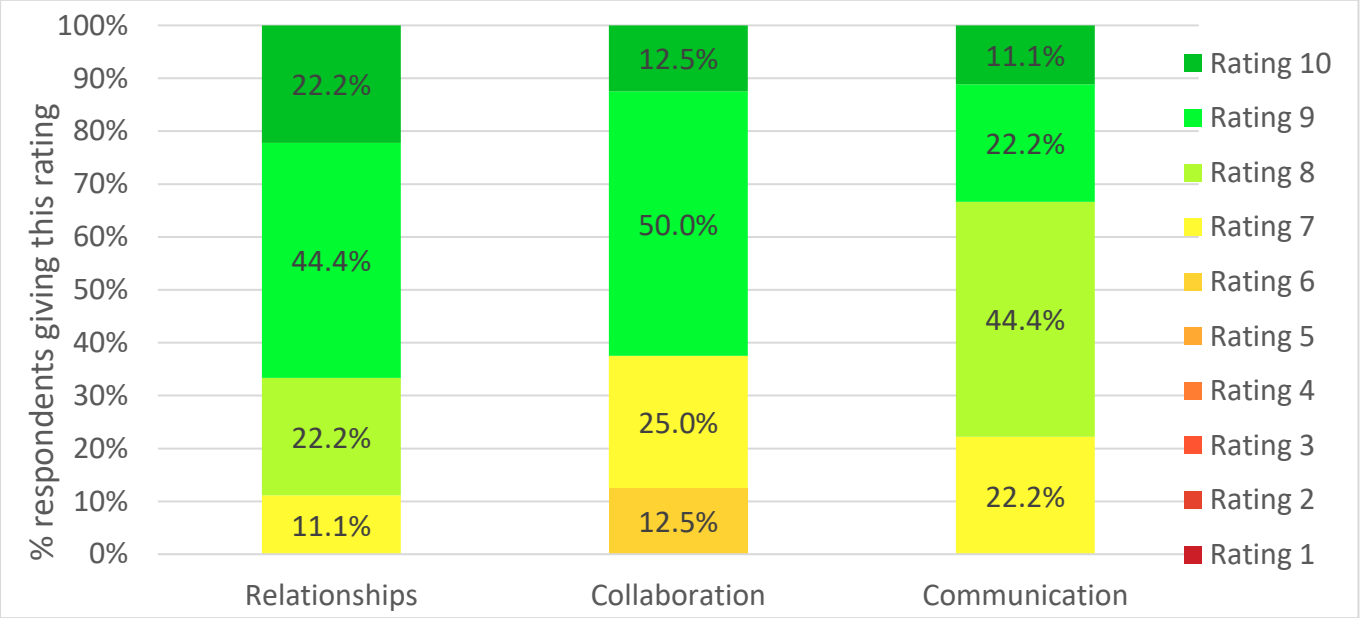
Relationships between the academic stakeholders and the designer were also valued highly. Thanks to the designer's expertise in the field they communicated well directly, filtering out detail on the build that wasn't necessary to pass on. Workshop attendees said that stakeholder engagement had been, on the whole, better than on a previous large capital project. However, they agreed that there had been a breakdown in communication around Barn 2.

While satisfied overall with communication, one member of the contractor team did find it challenging towards the end of the project where they were working directly with a number of different members of the Estates team who hadn't been involved previously. They would have welcomed overall coordination by the key project manager within Estates at this stage of the project.

Recommendations

- The Schools need to make the University aware of the experts whose involvement should be sought on any future projects
- Use the key stakeholders to spread engagement and get more key people involved at the right time.

Fig 2.0 Satisfaction with the relationships between members of the project team.



FEEDBACK RELATING TO MAIN CONTRACTOR AND SUPPLY CHAIN

The main contractor

The performance of the main contractor was viewed positively by respondents, with ratings of 'eight' or 'nine' awarded.

The members of the main contractor team were seen as personable and particularly good in the early stages of the project when they worked in partnership with the University and the architect to get the first phase completed, "when we were throwing money at them to get it done". Finish and attention to detail was viewed as "impressive" by one respondent. The contractor's experience in this type of build was highly valued and on the build side they performed well.

However, it was felt that the project "dragged on longer than it should" given the pace of activity at the beginning. There was some disappointment from one member of the academic team around the quality of the finish being less good in Barn 2, which had a number of teething problems.

Regarding health and safety, at times site practices, like wearing hard hats, needed to be repeatedly reinforced by members of the project team.

Recommendations:

- The project team and the main contractor should take steps to reinforce health and safety best practices, on site.

Supply chain

Subcontractors were not employed under the umbrella of the main contract, a decision taken in order to save money. Running them as separate 'mini contracts' did present challenges but was seen as being "worth the hassle".

There were lower levels of satisfaction, overall, from respondents around members of the supply chain, with respondents rating this as ‘just satisfied’. Some companies performed extremely well, however others were criticised for their work on the project. This is reflected in the ratings given which ranged from ‘four’, ‘slightly dissatisfied’, through to ‘nine’, ‘mostly satisfied’, depending on the individual respondent’s experience of working with different subcontractors.

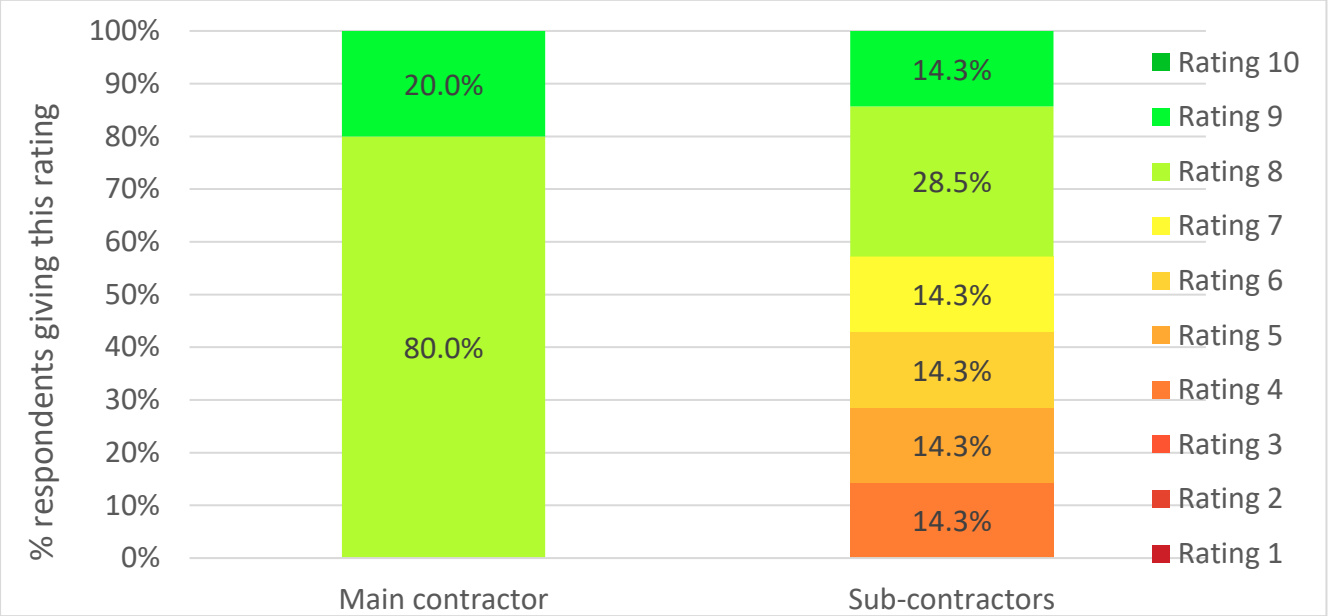
The supplier of the electronic feeders was seen as ‘efficient’ with a good follow up process.

The underground scraping system supplier has worked well with the University, sending a team over from Denmark to resolve some initial issues.

Despite some issues around the supply of robotic scrapers during the construction period, the supplier of robotic milking machines was seen as a good company to work with and the maintenance engineer is working well with the academics now the farm is up and running.

The supplier of the feed mixing equipment was viewed much less positively by a number of respondents. They were regarded as complacent, caused ‘huge’ delays and had less than tidy ways of working. While the cows moved into the Centre in December 2017, the feeding system wasn’t up and running until September 2018, delaying feed experiments. One respondent noted that: “For such a massive project, and what’s a relatively small part, they caused a lot of headaches and challenges.”

Fig 3.0. Satisfaction with the main contractor and subcontractors



FEEDBACK RELATING TO PROGRAMME

While this project did finish well ahead of the original date in the business case for the project, and was open by Christmas 2017 as planned, the length of time on site was longer than anticipated, by three or four months. After the initial speedy mobilisation period, the build was expected to finish even earlier. One respondent said: “We got off to such a flying start and it seemed to drift for a while towards the end.” While there were some delays to handover, there was seen to be good flexibility around how that would be managed on both sides. It was important that the herd had moved in by 18th December to ensure that support was available from key contractors before the holiday period. This was achieved and the whole project was on budget. This was seen as being ‘quite an achievement’ by the designer.

The quality of the project management by the University was considered to be a key strength of this project.

Planning was one of the biggest challenges with regards to the programme because this was an area out of the control of the University, however, the project team worked closely and consulted with planners. According to the architect, the local authority was ‘fantastic’ and understood the importance of the Centre. Other issues raised by local objectors to the site were handled well by the University, for example, conducting an ‘odour analysis’ to address any issues raised around slurry handling in fields neighbouring local residents.

One respondent feels that the tight timescale meant that there was little time to consider the design of all of the buildings, particularly the calf shed, which in their opinion ‘doesn’t work’. They noted: “With the calf sheds, they just copied the old shed which doesn’t work. Again, this was due to timing. If we had had time to get a group together to design something better, that would have been good. It was a time thing.”

While this project was mobilised swiftly in order to meet the strict timescales imposed by funders, there was a detailed discussion during the workshop around whether University governance procedures would now allow such a project to happen at such pace.

Involvement of the Home Office in plans at an earlier stage was a key learning for this project. However, again, there was concern that this could have delayed the project.

Recommendation

- For any future projects, look to involve the Home Office, or similar relevant bodies, earlier in the process.

FEEDBACK RELATING TO HANDOVER

There was a delay to handover, about a month, but one respondent noted that there was some good flexibility around how that was going to managed, on both sides. The team was, however, under significant pressure to complete the handover by 18th December, in order to get the cows into the new facility in time for Christmas. This made it stressful for the team, and contractors were working right up until the deadline because once the cows had been housed, no additional work could be completed within the sheds. However, the move did happen on time and according to one respondent it 'broadly' went well.

One respondent rated this as a 'ten' because of quite how happily the cows settled into the new facility: "within 24 hours they had made themselves at home." "To get them through the robots so quickly was testament to the building and them settling down and being happy straight away."

There were some delays to receiving the health and safety information after handover, however it was thought that was down to the contractor's own consultants. One respondent did note that the operation and maintenance manuals (O&Ms) took some time to come through, particularly on the electrical side, and were not as expected when received. However, they tempered this by explaining that this was a secondary concern to successfully moving the cows in.

Resolution of defects

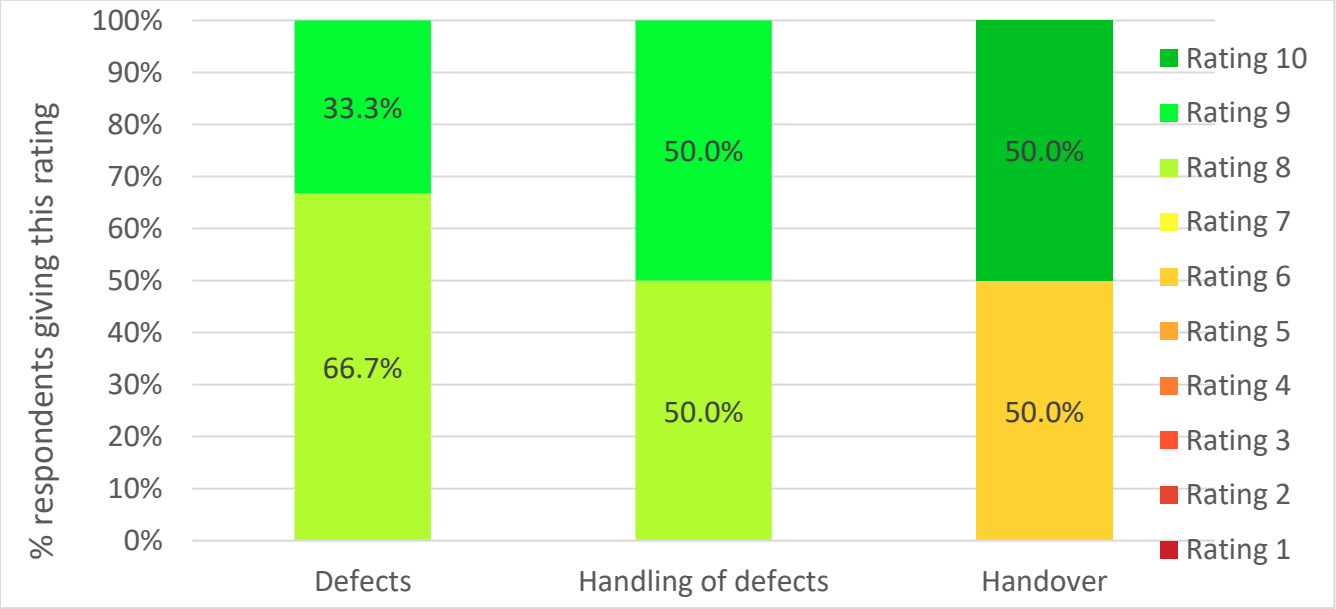
Generally, there is satisfaction among respondents as to the extent of defects at handover and how they have been resolved. One respondent noted: "Considering the size of the project, although the list was probably five pages long it was really short…It's usually missing things rather than defects." Because there would be cows in the space straight away, it was important that those were resolved prior to handover and, in the main, this had happened.

There is one ongoing issue with the floor in the milking area, for which, while it's been addressed by the contractor, some funding has been retained to see how that holds up. However, overall, the contractors have been responsive to issues and there were few quibbles in dealing with issues.

The Barn 2 Research facility has had a number of issues associated with it, and snags need to be resolved before it can be designated by the Home Office. These have included gaps where bars don't quite meet the walls, rough surfaces and matting in cubicles not being bolted down securely enough.

The small number of respondents who were in a position to rate the level of defects at handover, and how effectively they were handled, were all 'mostly satisfied', providing ratings of 'eight' or 'nine' in response to these questions.

Fig 4.0 Satisfaction with handover, the level of defects and how they were handled



QUALITATIVE FEEDBACK - POST-OCCUPATION ISSUES

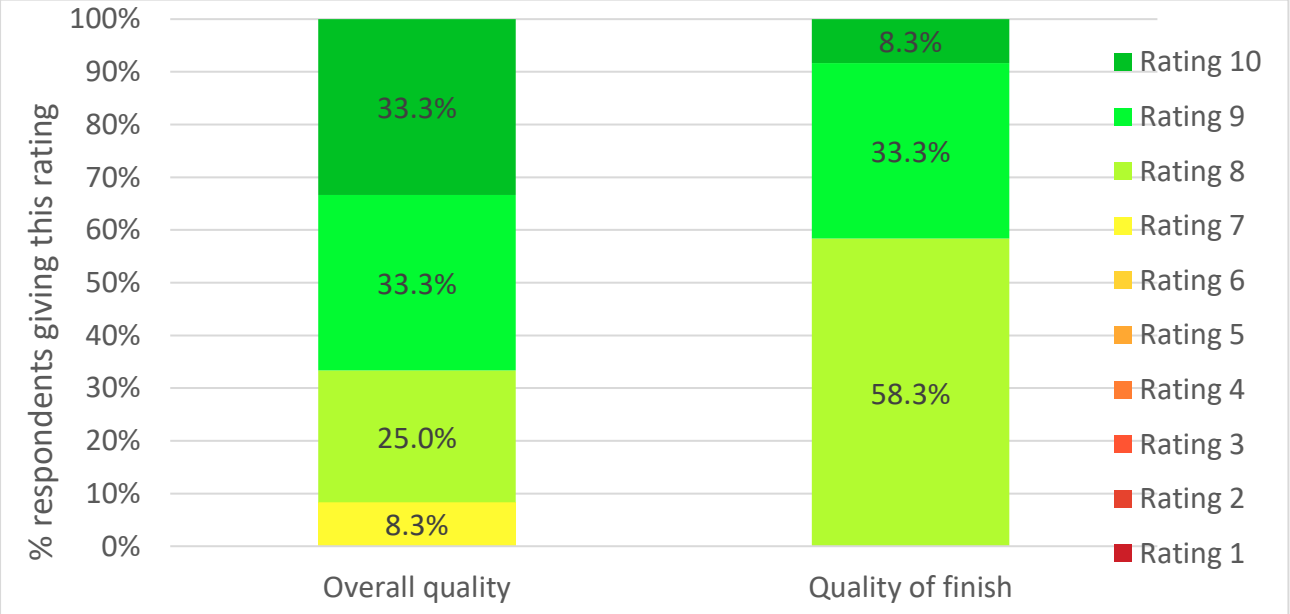
FEEDBACK RELATING TO THE QUALITY OF THE FINISHED PRODUCT

The quality of the finished product

There were high levels of satisfaction with the overall quality of the CDSI, with all but one respondent rating this as 'eight' or above. Four of the twelve respondents questioned give a rating of 'ten'; 'totally satisfied'.

The quality of the finish at the Centre was also rated extremely positively, with all respondents satisfied with the finish that had been provided.

Fig 5.0 Satisfaction with the overall quality and the quality of the finish at the CDSI



Functionality

"I think it has surpassed what we thought and is definitely a 'ten' for me. We thought the performance and health of the cows would be good, but it's been beyond what we could have hoped for really."

Overall, the CDSI rated highly for functionality with an average satisfaction rating of 'nine' out of ten. Almost uniformly, the main cow sheds are rated highly, with one respondent noting, "It is there to enable research into cows with great cow comfort and it does all of those things". The robotic milking of cows works well, as does the scraper system, and the notable lack of noise from the cows demonstrates how comfortable they are in the space. The crush was one area of concern, with the layout of the chosen unit making it difficult to complete certain surgical procedures.

For one respondent there was one minor issue with the Nutrition Barn. Once cows are pushed up to the robot and penned into the loafing area, there was no gap through which to access the robot, as was with the previous barn, so the dairy worker is required to walk round. While discussed at the workshop, there was felt to be no safe solution to rectify this. In the Flexible Barn, researchers are happy that they are able to modify the space as much as is necessary for their research. However, that does bring challenges, as the team looks for ways to manage cow flow within such a flexible space. In addition, there is little appropriate space available for the storage of equipment connected with research projects. Equipment has been stored in the robot room; however, this is not felt to be the most appropriate place.

The robot rooms were seen to be a good size by the contractor responsible for their maintenance.

The calving sheds do temper this satisfaction for some respondents. While some feel the calving and rearing sheds function better than the old system, others feel that there haven't been enough benefits to the younger cows. New funding has now been found for new facilities for the young stock and work had commenced at the time of writing this review.

Recommendations:

- If funding allows, look at the possibility of building storage areas in both the Flexible and Nutrition Barns
- In the short term, storage units are to be sourced from existing excess University stock.

Fig 6.0 Satisfaction with the functionality of the CDSI

FEEDBACK RELATING TO OPERATIONAL ISSUES

Operational issues

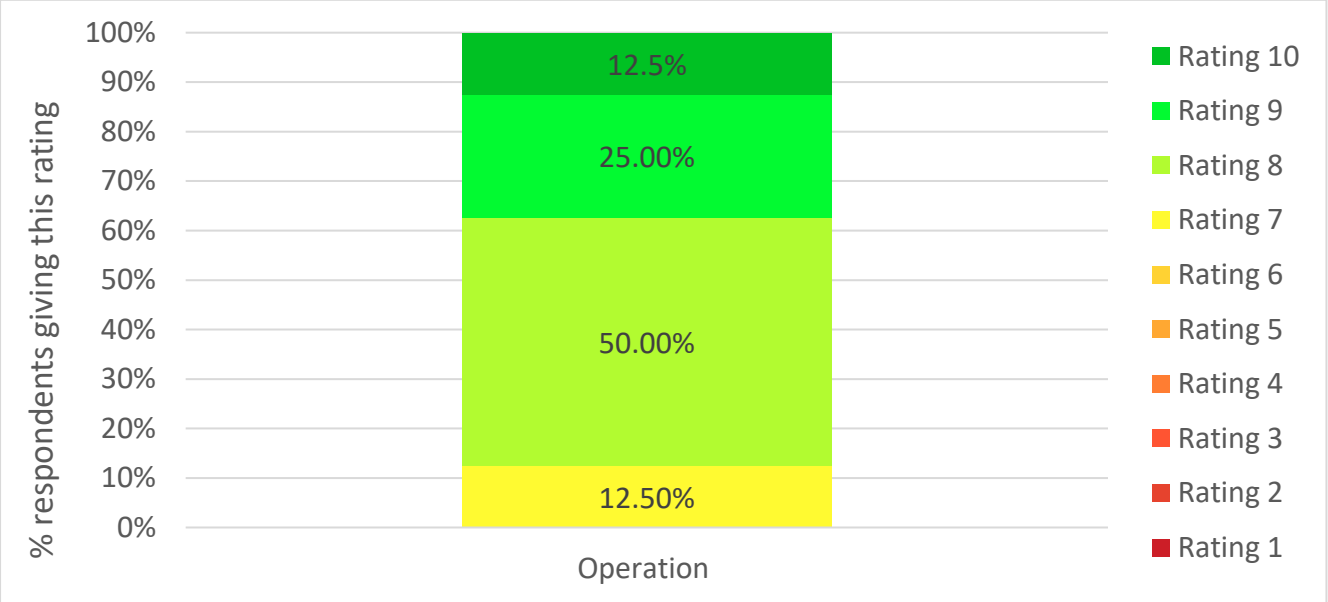
Most respondents are 'mostly satisfied' with the way the building operates, with one rating slightly lower with a 'seven', 'just satisfied', and one higher with 'totally satisfied'.

Respondents overall feel that it is a good facility which they take pleasure in showing people around. One respondent noted how much pleasure they take in talking about the CDSI because of all of the innovative elements to the Centre. Dairy staff prefer working in this shed as it's lighter, airier and cleaner than the previous facility.

The fact that the cows are happy, healthy and productive in the new environment is a key factor in the level of satisfaction respondents have about the way the Centre operates.

One respondent feels that while not directly connected to the building itself there is a conflict of interest between the research and commercial sides of what happens at the Centre. For example, having to use a commercial feed wagon to fit individual bins adds to time.

Fig 10.0 Satisfaction with how the building operates



Skylights

While skylights were largely omitted from the roof of most of the sheds, some were included in the centre of the Nutrition Barn, this has created hot spots within the shed which the cows find too hot. In retrospect, one respondent would have omitted them altogether.

Resin floors in robot areas

There was some confusion within the project team as to what the finish of the resin floor would be. A smoother coating was applied which subsequently peeled off, but this has now

been rectified. For one respondent this was one area of the build where the quality wasn't as good as in other areas.

Quality of the covering in the scraper channels

There was some discussion about whether high quality concrete in the scraper channels would be a benefit. It was mentioned that a supplier has come up with a proposal to put steel plates in the channels should damage occur.

Roof access above robot rooms

Access is required to the top of the rooms that house the robot milking machines. Two have stairs, but for two, access is purely via ladders which are unpopular with users. A bridge between the roofs would have helped access. Workshop attendees agreed that, were funding available, this access could be retrofitted.

Robotic scrapers

One respondent noted that they hadn't anticipated that the scrapers would rub against the doors.

Cold weather

During especially cold weather there have been some issues with equipment freezing. At the workshop, the group agreed that more trace heating was an urgent requirement.

Flexible building

One respondent, working primarily in the Flexible Barn, feels that the trade-off of the flexibility housing is the challenge of moving cows around without fixed points to help them do that. They are keen to seek out a solution to this, perhaps using a pull-out cord system.

Feed barriers

Feed barriers have required some snagging work, due to jagged edges appearing which could have injured the cows. Workshop attendees confirmed that this had now been rectified.

The crush

The crush was the one area of concern for those in the Flexible Barn, with the layout of the chosen unit making it difficult to complete certain surgical procedures.

Processing and storing samples

Technical staff would appreciate lab facilities to enable the immediate analysis of samples, immediately after they are taken. Currently, this is done by balancing kit on a trolley. A member of the technical staff in the Nutrition Barn reported that a fridge is required for the storage of milk samples; hundreds of these samples are taken every day.

Recommendations:

- Consider whether higher quality concrete in the scraper channels would be beneficial
- Review the plans put forward by a supplier to install steel plates in the scraper channels
- If budget can be made available, look at adding stairs and a bridge to enable access to the top of the robot rooms
- Modifications to the existing crush to be explored by the dairy manager in consultation with key stakeholders
- Modifications to the box section attached to the door, which can be managed by the dairy, could solve the issue of the robot scrapers rubbing against doors
- Additional frost protection to be installed as an urgent requirement
- Retractable electric reels or demountable gates could be explored as solutions to moving cows in the Flexible Barn
- Look at the possibility of adding some laboratory space to allow samples to be processed quickly and efficiently
- Look at the possibility of installing an upright fridge freezer for storage of milk samples.

FEEDBACK ON DATA CONNECTIVITY

There was a mixed response to the question about data connectivity, with most respondents rating themselves as ‘just satisfied’. Ratings ranged from ‘four’ to ‘ten’.

It was clear that there had been some issues with data connectivity, with one respondent noting that the time taken to sort it was a ‘nightmare’. One respondent also noted that there was a need for more ethernet points. Data connectivity, according to one respondent, is ‘variable’ and a router has need to be installed for one trial. Another explained that there had been lots of issues with data, and that students were having to visit the site to manually back up data due to a lack of Wi-Fi in areas of the farm. Backing up of databases and installing FTPs and general accessibility of data from the GEA, Hoko, T4C and Uniform have been problematic and staff have had to ‘cobble a system together’ to enable this transfer of data to the University systems, as there was little provision in place.

It was clear that there had been some disappointment from the team with the work of the University’s Information Systems (IS) team. While it was clear that some of the operational technology provision doesn’t meet the needs of users all of the time, there is capacity within the current system, budget allowing, to make changes to improve things for users.

Recommendations:

- Clearer communication is required as to needs and expectations of users, with regard to data connectivity, during the design phase
- A budget needs to be allocated to solving issues with operational technology and increasing the number of ethernet points
- Ensure that connectivity is addressed fully as part of the project’s ‘red line’ scope.

FEEDBACK RELATING TO THE QUALITY OF THE INTERNAL ENVIRONMENT

Light

Energy efficient smart LED lights have been installed in the Centre, which means that they automatically switch on and off depending on the light in the shed. The artificial lighting was viewed positively by respondents. One respondent said, “It’s incredible, it’s a ‘ten’ with the height of the ceiling and pitch of the roof. I have seen a lot of cow sheds and it’s incredible.”

Respondents were overall ‘mostly satisfied’ with the lighting, explaining that it is very effective. One respondent did note, however, that there was an imbalance in lighting between two sheds, with the Flexible Barn appearing lighter than the Nutrition Barn. Two respondents did note that the Flexible Barn could sometimes be a little gloomy. However, they appreciated that roof lights had not been installed due to the heat spots they create in the shed, which cows do avoid.

Recommendations:

- The dairy manager will continue to explore issues with the lighting sensors in the Flexible Barn.

Environmental conditions for cattle

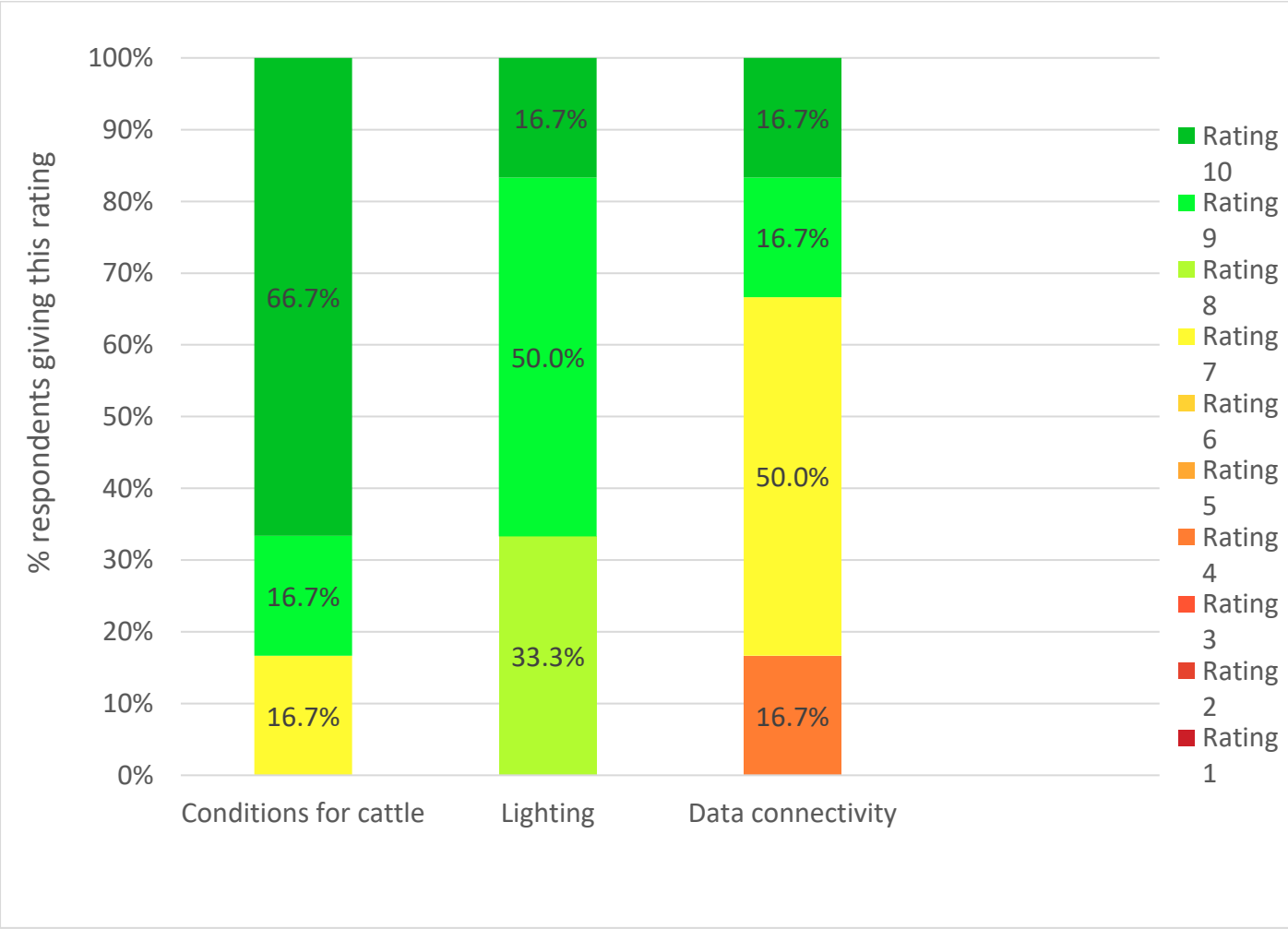
For the facilities for adult cows, the response to this question was overwhelmingly positive, with the majority of ratings to this question being a ‘ten’: ‘totally satisfied’. The facility has been visited from people from across the world, eager to see it in operation.

Respondents feel that the facility has exceeded expectations in terms of the environment for cows. The temperature, even during the hot summer of 2018, remained cool, which is preferred by cows, and respondents feel that this is why it’s been successful. There is more space for the cows to move around, ventilation is good, and the calm environment enables them to perform all of their innate behaviours. “I’m convinced this is why it’s been so successful. It’s the quality of the environment inside.” Another added; “That would be a ‘ten’. The proof is 2000 extra litres per cow, the extra visits, reduced disease and increased animal health.”

One respondent noted how well this facility compares with others he has visited: “I don’t know what I’d improve. In terms of pretty much any other building, of similar function, it far exceeds 99% of them…The cows are so much better.”

One respondent, while acknowledging how good the environment is for adult cows, did rate the environmental conditions for calves much lower, a ‘five’; “The calves we have built the same shed for, that was already bad, and it’s still bad.”

Fig 7.0 Satisfaction with the internal environment



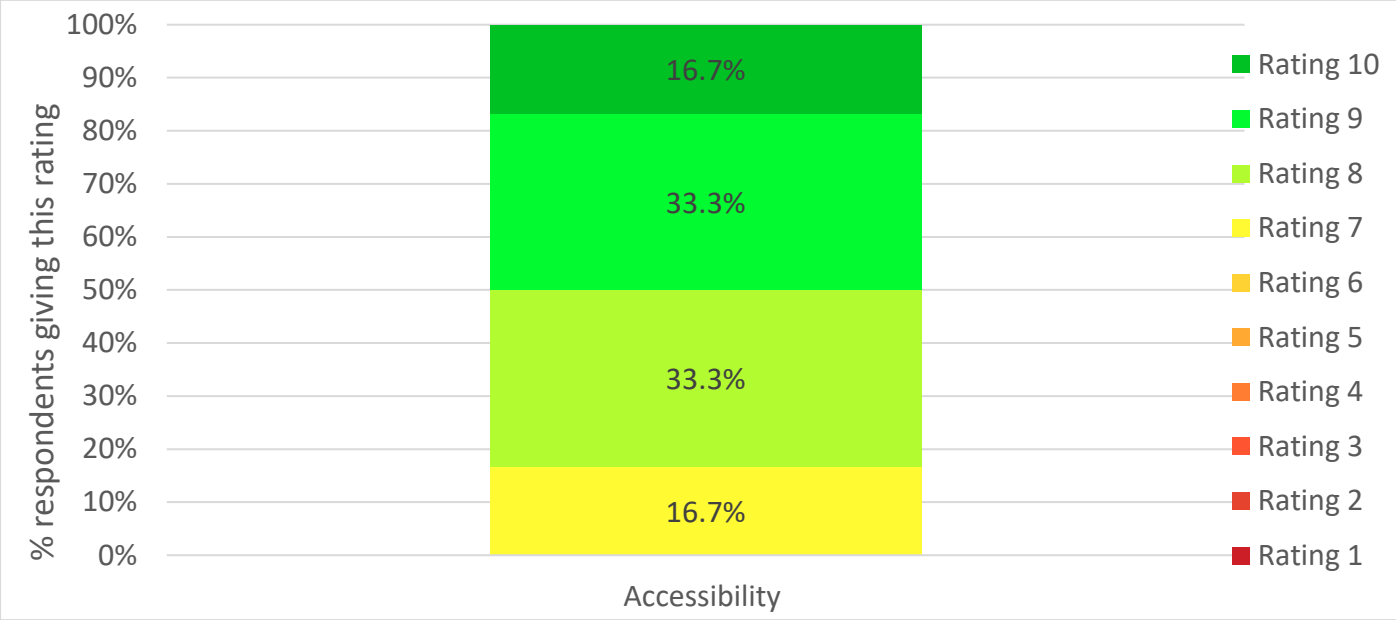
FEEDBACK RELATING TO ACCESSIBILITY

Accessibility on the farm was deemed to be appropriate by respondents, being accessible for those who need to access it, yet adhering to biosecurity requirements. There is a lift in the reception area, which allows access to the raised gantry and viewing deck for wheelchair users and those with limited mobility, and the wide feed passages also allow wheelchair users to see the cows close up.

One respondent noted that there are parts of the farm that are more difficult to get to, but that was the nature of the farm. Another noted that some of the routes Centre users need to take are quite 'convoluted', for example, getting from the office to the reception.

According to one respondent, an assumption was made at the beginning of the project that most people would drive there. Once the CDSI was up and running it became clear that many people wanted to walk over from the Sutton Bonington campus. This has resulted in an additional piece of work now being planned, at a cost of £160k, to provide a road crossing and footpath to allow safe access.

Fig 8.0 Satisfaction with accessibility in the CDSI



FEEDBACK RELATING TO SECURITY

Security

Overall, there was satisfaction with the level of security on site; respondents think it is as good as it is going to get without being totally enclosed. There is a gate at the entrance with keypad entry, rooms require key card access and staff were trained to approach anyone on site who they didn't recognise. Those who work at the Centre liaise with security as to the actions that would be taken in different scenarios, such as animal rights protestors. One respondent summed up the feedback: "I wouldn't pretend it's 100% secure all the time but I don't easily see how we could change it and wouldn't want a 24/7 guard approach."

No security breaches were reported by respondents and most reported feeling safe and not having serious worries in that regard.

Quantitative ratings show that most respondents are 'mostly satisfied' with security, rating this question as either an 'eight' or a 'nine'. One respondent rated this as a 'seven': just satisfied.

Biosecurity

Biosecurity was rated less positively than general security by respondents. There were mixed responses to how successful this element of the farm is. Procedures are in place for visitors to report to reception and receive protective clothing, but some respondents accepted that this system is not always followed. Farm access routes have also been changed to segregate visitors and other vehicles. There was also no designated dirty/clean dividing line.

For some, this is an area where improvements could be made. They noted that people were often seen without personal protective equipment on, there were no disinfectant stations and they were unsure as to how regularly disinfectant mats were topped up. The openness of the farm means that it is vulnerable to people not taking appropriate steps to address

biosecurity, such as wearing overshoes or walking into the sheds themselves rather than using the gantry. One respondent noted, “That is something that we need to be vigilant and aware of. There are aspects that could be better. We need to keep talking about that.”

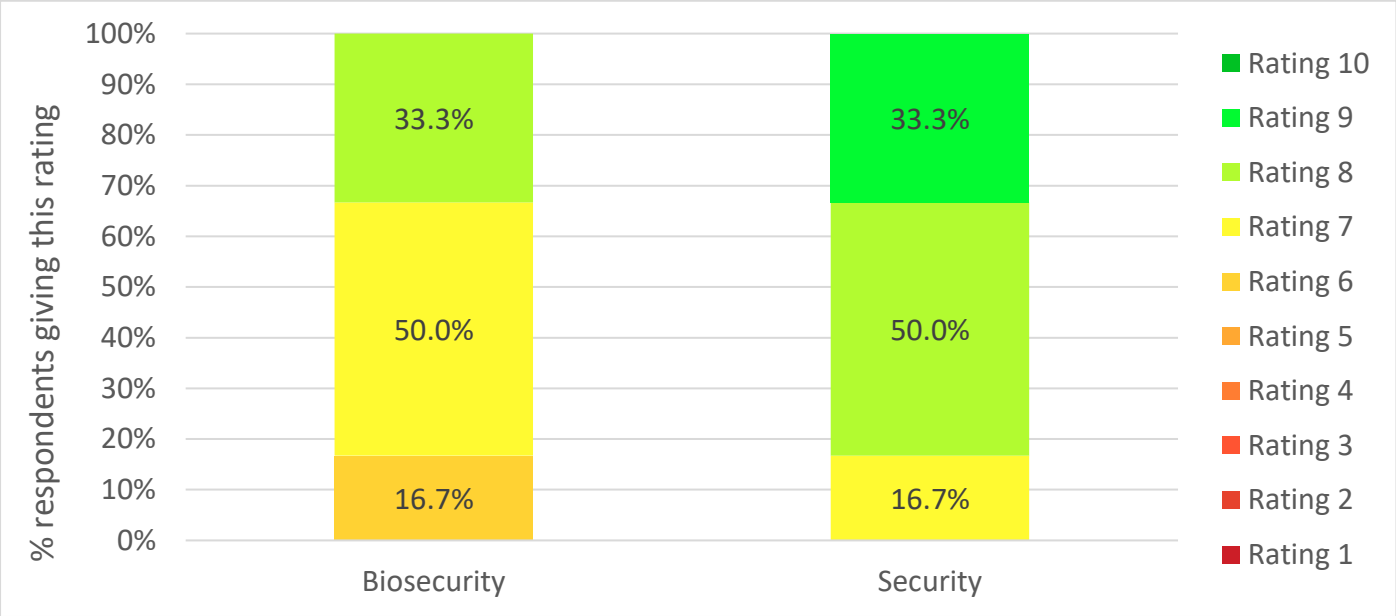
Others feel that the farm is “pretty clean for a dairy cow shed”, and that biosecurity is as good as it can be.

Quantitative ratings reflect slightly lower levels of satisfaction with biosecurity, with most respondents saying they were ‘just satisfied’ with biosecurity and rating this a ‘six’ or a ‘seven’. Workshop attendees felt that biosecurity was a management issue and simple steps could be taken to improve this. However, realistic budget needs to be allocated to the supply of personal protective equipment (PPE).

Recommendations:

- Formulate and highlight management procedures for biosecurity
- Improve signage around the farm, including a contact number (for the dairy manager) for visitors to call as soon as they arrive on site
- Establish routes to walk through the building and clear instructions on how to dispose of used PPE.

Fig 9.0 Satisfaction with security and biosecurity at CDSI



FEEDBACK RELATING TO SUSTAINABILITY

Due to the nature of this project, no environmental performance targets have been set for this development and the University would not be seeking accreditation from BREAAM.

Despite the original business plan stating that the project would underline the University’s commitment to be a leading green University, respondents at the workshop felt that opportunities were missed to achieve this. When asked what they would do if they could turn

the clock back, they explained that they regretted not taking the time at the beginning of the project to explore the cost effectiveness of energy saving measures, such as solar panels. However, it was felt at the time that the timescales in those early days, combined with budget constraints made this unfeasible. The lack of green initiatives does now present a challenge when showing visitors round the Centre as they often raise questions about matters such as the recycling of the sand.

It was acknowledged by the respondents that the questions being asked around dairy, globally, are different to those of five years ago. If that have been known at the time of planning, there might have been more planning for delivering and communicating sustainability.

Workshop respondents also noted that methane emissions have reduced as a result of the new dairy and there is an opportunity to communicate this to the wider public.

Recommendations:

- Future projects should be linked more closely to the University strategy for sustainability, which will encourage projects like these to factor this into plans
- Raise the profile of what the dairy is achieving on sustainability, such as the reduction of methane
- Explore opportunities to retrofit elements such as photo voltaic panels, an anaerobic digester or bore holes for water.

APPENDIX I: SUMMARY OF RECOMMENDATIONS

Budget

- **When visiting other facilities abroad, request data regarding their lifetime and operating costs, to feed into any business plan.**
- **Endeavour to obtain better estimates for costs of labour and machinery.**
- **Factor in the increased volume of machinery and larger amount of maintenance cost.**
- **Consider how best to forecast maintenance budget increases. (This was done by cow, but it may have also been helpful to have done the calculations by area).**

The Business Case

- **For future projects, ensure closer involvement of the schools in project business plans.**
- **Ensure buy-in from senior managers to the business plan, so if key stakeholders leave the University, knowledge is not lost.**
- **A meeting needs to be arranged to across University departments, to explore the facilities available for research, and any limiting factors that would affect this.**
- **Consider the possibility of involving other PIs (Principle Investigators) to win grants for research work at the CDSI.**
- **Consider the possibility of appointing a business development director to focus on bringing research grants into the CDSI.**
- **Think about pulling together a strategy for securing the amount of research funding required.**

Barn 2

- **The University to explore the barriers to commissioning Barn 2 with the School of Veterinary Medicine.**
- **Going forward, ensure that relevant experts and key stakeholders are consulted fully on key elements of the project.**

Lessons to be applied to the Calf Shed project

- **Involve experts in the design from the outset.**
- **Consult all the potential users.**
- **Look at incorporating local storage for research equipment.**
- **Involve the Home Office early in the process, if required**

Communication

- **The Schools need to make the University aware of the experts whose involvement should be sought on any future projects.**
- **Use the key stakeholders to spread engagement and get more key people involved at the right time.**

Health and safety

- **The project team and the main contractor should take steps to reinforce health and safety best practices, on site.**

Programme

- **For any future projects, look to involve the Home Office, or similar relevant bodies, earlier in the process.**

Functionality

- **If funding allows, look at the possibility of building storage areas in both the Flexible and Nutrition barns.**
- **In the short term, storage units are to be sourced from existing excess University stock.**

Operational issues

- **Consider whether higher quality concrete in the scraper channels would be beneficial.**
- **Review the plans put forward by a supplier to install steel plates in the scraper channels.**
- **If budget can be made available, look at adding stairs and a bridge to enable access to the top of the robot rooms.**
- **Modifications to the existing crush to be explored by the dairy manager in consultation with key stakeholders.**
- **Modifications to the box section attached to the door, which can be managed by the dairy, could solve the issue of the robot scrapers rubbing against doors.**
- **Additional frost protection to be installed as an urgent requirement.**
- **Retractable electric reels or demountable gates could be explored as solutions to moving cows in the Flexible Barn.**
- **Look at the possibility of adding some laboratory space to allow samples to be processed quickly and efficiently.**
- **Look at the possibility of installing an upright fridge freezer for storage of milk samples.**

Light

- **The dairy manager will continue to explore issues with the lighting sensors in the Flexible Barn.**

Data connectivity

- **Clearer communication is required as to needs and expectations of users, with regard to data connectivity, during the design phase.**
- **A budget needs to be allocated to solving issues with operational technology and increasing the number of ethernet points.**
- **Ensure that connectivity is addressed fully as part of the project's 'red line' scope.**

Biosecurity

- **Formulate and highlight management procedures for biosecurity.**
- **Improve signage around the farm, including a contact number (for the dairy manager) for visitors to call as soon as they arrive on site.**
- **Establish routes to walk through the building and clear instructions on how to dispose of used PPE.**

Sustainability

- **Future projects should be linked more closely to the University strategy for sustainability, which will encourage projects like these to factor this into plans.**
- **Raise the profile of what the dairy is achieving on sustainability, such as the reduction of methane.**
- **Explore opportunities to retrofit elements such as photo voltaic panels, an anaerobic digester or bore holes for water.**

APPENDIX II: MILK MONITOR – ROLLING ANNUAL REPORT

MilkMonitor

Rolling Annual Report

August 2019

U001 - Dairy Centre, University of Nottingham,

MONTHLY TOTALS **ROLLING**

LIVESTOCK DETAILS	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Aug 2019
Cows In Herd	251	249	259	252	254	265	273	289	304	294	308	308	276
Cows In Milk	234	216	226	222	223	235	241	254	263	271	287	277	246
Dry Cow %	7	13	13	12	12	11	12	12	13	8	7	10	11
Cow Calvings	10	13	20	19	17	15	19	22	18	21	16	20	210
Heifer Calvings	6	8	13	3	7	14	8	17	18	8	15	10	127
Cows Purchased	0	0	0	0	0	0	0	0	0	0	0	0	0
Cows Culled/Died/Sold	0	9	0	6	4	2	0	1	1	18	1	10	52

MILK PRODUCTION DETAILS	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Aug 2019
Milk Produced In Month *(Litres)*	266,045	262,907	260,207	266,430	270,193	249,208	293,186	298,247	322,647	329,877	351,225	360,674	3,530,846
Monthly Yield Per Cow *(Litres)*	1,060	1,056	1,005	1,057	1,064	940	1,074	1,032	1,061	1,122	1,140	1,171	12,783
Daily Yield Per Cow In Milk *(Litres)*	37.9	39.3	38.4	38.7	39.1	37.9	39.2	39.1	39.6	40.6	39.5	42.0	39.3
Yield From Forage Per Cow In Milk *(Litres)*	12.0	5.1	7.7	11.3	10.5	10.5	14.7	17.3	12.2	0.0	9.3	7.5	3,188
Daily Milk Produced *(Litres)*	8,868	8,481	8,674	8,595	8,716	8,900	9,458	9,942	10,408	10,996	11,330	11,635	9,667
Milk Price *(ppl)*	32.05	31.41	31.39	30.22	29.43	28.94	28.63	27.87	27.23	27.23	30.48	31.02	29.61
Total Milk Value *(£)*	85,259	82,567	81,691	80,516	79,524	72,122	83,938	83,110	87,865	89,824	107,070	111,876	1,045,362
Butterfat *(%)*	3.92	3.96	4.00	3.95	3.98	4.06	3.98	4.00	4.03	3.80	3.69	3.91	3.94
Protein *(%)*	3.19	3.21	3.26	3.23	3.23	3.19	3.18	3.19	3.14	3.13	3.12	3.13	3.18
Milk Solids *(kg per cow per day)*	2.77	2.89	2.86	2.86	2.90	2.82	2.89	2.89	2.92	2.89	2.76	3.04	936
Bactoscan	22	21	22	19	12	15	22	21	21	25	18	12	19
Cell Count	137	125	106	90	81	79	81	86	90	96	104	116	99

FEED COST DETAILS	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Aug 2019
Total Concentrates Fed/Month *(Tonnes)*	79.54	101.54	92.78	85.69	92.91	79.48	78.39	72.19	97.11	143.27	116.58	132.23	4.25
Concentrates Fed Per Litre *(Kgs)*	0.30	0.39	0.36	0.32	0.34	0.32	0.27	0.24	0.30	0.43	0.33	0.37	0.33
Concentrate Cost Per Tonne *(£/t)*	336	318	319	303	313	336	328	332	328	286	303	293	316
Other Feed Costs *(£)*	0	0	0	0	0	0	0	0	0	0	0	0	0
Purchased Feed Cost Per Litre *(ppl)*	10.04	12.29	11.36	9.74	10.76	10.70	8.76	8.03	9.88	12.44	10.04	10.73	10.40

MARGIN DETAILS	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Aug 2019
Margin Over Purchased Feeds Per Litre *(ppl)*	22.01	19.12	20.04	20.48	18.67	18.24	19.86	19.84	17.36	14.79	20.44	20.29	19.26
Margin Over Purchased Feeds Per Cow *(£)*	233	202	201	217	199	171	213	205	184	166	233	238	2,462
Margin Over Purchased Feeds For Herd *(£)*	58,558	50,267	52,137	54,560	50,459	45,447	58,241	59,164	56,002	48,789	71,796	73,168	678,587
Margin Over All Feeds Per Litre *(ppl)*	20.51	17.60	18.50	18.98	17.25	16.86	18.79	18.82	16.42	14.00	19.59	19.46	18.07
Margin Over All Feeds Per Cow *(£)*	217	186	186	201	183	159	202	194	174	157	223	228	2,311
Margin Over All Feeds Per Herd *(£)*	54,558	46,267	48,137	50,560	46,609	42,022	55,091	56,139	52,977	46,196	68,821	70,193	637,569

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APPENDIX III: MILK MONITOR, MONTHLY REPORT FOR AUGUST 2019

MilkMonitor

Monthly Report

August 2019

U001 - Dairy Centre, University of Nottingham,

MONTHLY TOTALS

LIVESTOCK DETAILS	Aug - 2019	Aug - 2018
Cows In Herd	308	245
Cows In Milk	277	224
Dry Cow %	10	9
Cow Calvings	20	11
Heifer Calvings	10	8
Cows Purchased	0	0
Cows Culled/Died/Sold	10	1

MILK PRODUCTION DETAILS	Aug - 2019	Aug - 2018
Milk Produced In Month *(Litres)*	360,674	279,803
Monthly Milk Yield Per Cow *(Litres)*	1,171	1,142
Daily Yield Per Cow In Milk *(Litres)*	42.0	40.3
Yield From Forage Per Cow In Milk *(Litres)*	7.5	10.45
Daily Milk Produced *(Litres)*	11,635	9,026
Milk Price *(ppl)*	31.02	31.58
Total Milk Value *(£)*	111,876	88,365
Butterfat *(%)*	3.91	3.72
Protein *(%)*	3.13	3.07
Milk Solids *(kg per cow per day)*	3.04	2.81
Bactoscan	12	17
Cell Count	116	137

FEED COST DETAILS	Aug - 2019	Aug - 2018
Total Concentrates Fed *(Tonnes)*	132.23	87.11
Concentrates Fed Per Litre *(Kgs)*	0.37	0.31
Concentrates Cost Per Tonne *(£/t)*	293	315
Other Feed Costs *(£)*	0	0
Purchased Feed Cost Per Litre *(ppl)*	10.73	9.82

MARGIN DETAILS	Aug - 2019	Aug - 2018
Margin Over Purchased Feeds Per Litre *(ppl)*	20.29	21.76
Margin Over Purchased Feeds Per Cow *(£)*	238	249
Margin Over Purchased Feeds For Herd *(£)*	73,168	60,891
Margin Over All Feeds Per Litre *(ppl)*	19.46	20.33
Margin Over All Feeds Per Cow *(£)*	228	232
Margin Over All Feeds Per Herd *(£)*	70,193	56,891

ROLLING ANNUAL TOTALS

LIVESTOCK DETAILS	Aug - 2019	Aug - 2018
Cows In Herd	276	218
Cows In Milk	246	194
Dry Cow %	11	11
Cow Calvings (% Calved in year)	210 (76 %)	154 (71 %)
Heifer Calvings	127	94
Cows Purchased	0	0
Cows Culled/Died/Sold (% Culled in year)	52 (19 %)	59 (27 %)

MILK PRODUCTION DETAILS	Aug - 2019	Aug - 2018
Milk Produced In Year *(Litres)*	3,530,846	2,532,314
Milk Yield Per Cow *(Litres)*	12,783	11,511
Daily Yield Per Cow In Milk *(Litres)*	39.3	35.3
Yield From Forage Per Cow In Milk *(Litres)*	3,188	2,381
Daily Milk Produced *(Litres)*	9,667	6,931
Milk Price *(ppl)*	29.66	28.63
Total Milk Value *(£)*	1,045,362	723,693
Butterfat *(%)*	3.94	3.86
Protein *(%)*	3.18	3.20
Milk Solids (Kg/Cow)	936	835
Bactoscan	19	16
Cell Count	99	123

FEED COST DETAILS	Aug - 2019	Aug - 2018
Total Concentrates Per Cow *(Tonnes)*	4.25	4.15
Concentrates Fed Per Litre *(Kgs)*	0.33	0.36
Concentrates Cost Per Tonne *(£/t)*	316	306
Other Feed Costs *(£)*	0	0
Purchased Feed Cost Per Litre *(ppl)*	10.40	10.78

MARGIN DETAILS	Aug - 2019	Aug - 2018
Margin Over Purchased Feeds Per Litre *(ppl)*	19.26	17.85
Margin Over Purchased Feeds Per Cow *(£)*	2,462	2,054
Margin Over Purchased Feeds For Herd *(£)*	678,587	452,196
Margin Over All Feeds Per Litre *(ppl)*	18.07	14.86
Margin Over All Feeds Per Cow *(£)*	2,311	1,728
Margin Over All Feeds Per Herd *(£)*	637,569	382,839

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Milk Monitor I Tel: 01902 851007 I Fax: 01902 851058

APPENDIX IV: ACHIEVEMENT AGAINST THE KEY OBJECTIVES FOR THE CDSI PROJECT

Key objective	Progress towards achieving key objective
Increase herd to 300 milking cows, 360 total herd	Three-year plan building up to target through breeding replacement cows. Currently herd is 270, on track to achieve target.
Create 'Nutritional Research Unit' for 100 milking cows	This objective has been achieved.
Create Nutritional Research Unit' for 100 milking cows	This objective has been achieved.
Create 'Commercial Unit' for 100 milking cows.	This objective has been achieved.
Create a 'Containment Level 2 Research Facility' to facilitate in vivo infection studies.	The space has been created but is not yet operational.
Improve public access with purpose-built visitor centre with reception, information areas and high-level walkway.	This has been partially achieved. A walkway has been installed in the Nutrition Barn, but it doesn't reach the Flexible Barn. The reception area, while used for visitors, isn't as impactful as originally hoped.
Finalise and Commission Design by March 2018	The CDSI was delivered in December 2017.
Increase research funding to a minimum of £2m pa	This has not been met.
A minimum of £4m research awards by March 2020	Since facility opened £2.7m has been awarded.
A minimum of £10m research awards by March 2023	No feedback was received.

A minimum of four Impact Cases from the Dairy Science research groups for REF 2020.	This is on target.
A minimum of six new commercial collaborations (not in place at the start of the project) that produce research through the new facility by 30th March 23	This is on target.
A minimum of four new external academic collaborations (not in place at the start of the project) that produce research through the new facility and co-authored peer reviewed papers by 30th March 23	One collaboration is in place, so far. The workshop respondents were confident that this was achievable.
NPV of +1.4m and additional contribution to the University of £0.6m per year	The post-project updated proposal generates a negative NPV of £3,576k over 10 years due to the heavy initial outlay. The case does payback in year 19 and requires a University investment of £3.2m, producing a negative return of 110%. The facility is yet to make any additional contribution to the University.
Capital outlay of £5.98m	Final outlay £6.2m; within 5% of original budget.

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