

To cite this output:

Holloway, LE, Bear, C, (2013) Robotic and Information Technologies in Livestock Agriculture: New Relationships between Humans, Cows and Machines
ESRC End of Award Report, RES-062-23-2086. Swindon: ESRC.



ESRC End of Award Report

For awards ending on or after 1 November 2009

This End of Award Report should be completed and submitted using the **grant reference** as the email subject, to reportsofficer@esrc.ac.uk on or before the due date.

The final instalment of the grant will not be paid until an End of Award Report is completed in full and accepted by ESRC.

Grant holders whose End of Award Report is overdue or incomplete will not be eligible for further ESRC funding until the Report is accepted. We reserve the right to recover a sum of the expenditure incurred on the grant if the End of Award Report is overdue. (Please see the ESRC Research Funding Guide for details.)

Please refer to the Guidance notes when completing this End of Award Report.

Grant Reference	RES-062-23-2086		
Grant Title	Robotic and information technologies in livestock agriculture: new relationships between humans, cows and machines		
Grant Start Date	21 June 2010	Total Amount	£177,615
Grant End Date	30 November 2012	Expended:	
Grant holding Institution	University of Hull		
Grant Holder	Dr. Lewis Holloway		
Grant Holder's Contact Details	Address	Email	
	Department of Geography University of Hull Cottingham Road Hull HU6 7RX	l.holloway@hull.ac.uk	
		Telephone	01482 466759
Co-Investigators (as per project application):	Institution		
Dr. Christopher Bear	Cardiff University		

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I. Non-technical summary

Please provide below a project summary written in non-technical language. The summary may be used by us to publicise your work and should explain the aims and findings of the project. *[Max 250 words]*

Robotic milking technologies are becoming increasingly important in UK dairy farming, as well as elsewhere in Europe and in North America. Robotic milking machines milk cows automatically at any time, without the need for human workers to be present. Cows choose when to be milked, enter the robot, are milked and return to the herd.

This project investigated how the introduction of robots may change the ways dairy farmers manage their farms and businesses, and might affect the farmer-cow relationship.

The research focused on three central themes:

1. How technologies change farm practices.
2. How farmers learn and make decisions
3. Health, welfare and agricultural ethics.

The research involved in-depth interview research with users and non-users of robots, with a range of institutions associated with dairy farming and robotic milking development and manufacture. It also involved periods of observation on dairy farms.

The research demonstrated that:

1. Automatic milking systems don't just fit in to farms' specific circumstances and human-animal relationships; they reconfigure farms and farming routines and practices.
2. Farmers' experiences of robots vary: they gain flexibility but face demands to learn a new 'philosophy' of dairy farming and always be on call.
3. Farmers using robots consistently experiment and tinker with the robots and with the farm system they are part of.
4. Farmers using robots have to learn to make use of the large quantities of data produced, and to build their work routines around data analysis and rapid responses to what the data tells them.

2. Project overview

a) Objectives

Please state the aims and objectives of your project as outlined in your proposal to us. *[Max 200 words]*

The overall research aim was to examine the farm-scale and wider implications of robotic milking technologies (also known as Automatic Milking Systems, AMS) in dairy farming.

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There were 4 specific research objectives:

1. To examine the co-constitution of technologies, dairy cows and humans, and to analyse the impacts of technological change in dairy farming on the relationships between humans and dairy cows, and on the behaviours and subjectivities of individual humans and animals.
2. To investigate the processes of production and circulation of knowledges about robotic milking technologies, and the contribution of animals and technologies to these processes.
3. To examine the ethical issues raised by the advent and use of novel technologies in livestock agriculture, and to investigate how these can be addressed.
4. To develop innovative methods for researching inter-relationships between humans, nonhuman animals and technologies, in which animals and technologies are involved as active participants in the research process.

b) Project Changes

Please describe any changes made to the original aims and objectives, and confirm that these were agreed with us. Please also detail any changes to the grant holder's institutional affiliation, project staffing or funding. *[Max 200 words]*

1. During the life of the project, Dr. Christopher Bear (co-investigator) moved from Aberystwyth University to Cardiff University.
2. The PDRA first appointed to the project, Dr. Katy Wilkinson, left in December 2011 to take up another appointment. The PI successfully applied to the ESRC for a project extension to the end of November 2012 to allow time to make a new appointment. Dr. Deborah Butler was appointed as a replacement and worked for 6 months until the end of October 2012.
3. Neither of these changes affected the funding for the project.
4. There was a slight underspend (£3913) on the FEC awarded to the research (£181,529). Staff costs were £1174 less than expected; travel costs were £1422 less than expected and 'other' costs were £1317 less than expected.

c) Methodology

Please describe the methodology that you employed in the project. Please also note any ethical issues that arose during the course of the work, the effects of this and any action taken. *[Max 500 words]*

The research involved 59 detailed interviews with dairy farmers and dairy farm workers, staff on the research farms of agricultural colleges, agricultural scientists and researchers involved in developing robotic milking technologies, the companies marketing robotic milking equipment and representatives of a wide range of organisations including veterinary practices, those concerned with animal welfare, and specialist dairy feed and management companies. It involved periods of research on three case study farms, during which the

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routines and behaviours of both cows and humans were observed. The case studies included the college farm at Askham Bryan College, a commercial farm with a well established robotic dairy, and a commercial farm in the process of converting from conventional to robotic milking. Three focus groups, with farmers and agricultural students, were also conducted.

In detail, the empirical research involved the following methodological stages:

1. 'Scoping' interviews were conducted with 11 farmers using robotic milking technologies, 1 farmer in the process of converting to robotic milking and 10 farmers using 'conventional' milking equipment. In addition, interviews were conducted with three manufacturers of robotic milking equipment used in the UK.
2. Periods of observational research on the three case study farms were undertaken. Each case study farm was visited twice, in the first instance for a week and for shorter periods of time for the second visit. Visits included interviews with farmers alongside extended observational work focusing on human-animal-technology relationships.
3. Interviews with eight UK organisational representatives were conducted, covering interests in cow health and welfare, the dairy sector and technology development. Interviews were also conducted with representatives of three agricultural colleges which included dairy farming in their curriculum and on their college farms (one college used robots, one did not, and the third had used robots but then removed them); a focus group with students was also conducted at two of these colleges.
4. A focus group was conducted drawing on an existing dairy farmer discussion group in North Yorkshire; this event presented key findings from earlier parts of the research and aimed to generate wider discussion of the issues raised.
5. Overseas research trips were undertaken in the Netherlands, Scandinavia and the USA. In the Netherlands and Scandinavia, 16 interviews were conducted with institutions and companies with interests in developing and marketing robotic milking. In the USA seven interviews were conducted with dairy farmers, focusing on the potential use of robotic milking in a very different geographical context.

d) Project Findings

Please summarise the findings of the project, referring where appropriate to outputs recorded on the ESRC website. Any future research plans should also be identified. *[Max 500 words]*

Key findings include the following. 1 – 4 relate to Objectives 1-3; 5 relates to Objective 4.

1. Farmers use robots in unique ways relating to their personalities and specific characteristics of their farms. Technology adoption and use is complex because the technology has to fit into all sorts of existing circumstances and relationships. A robot isn't just a new machine – it implies adopting other things, particularly a different 'philosophy' of dairy farming.
2. AMS don't just fit in to existing circumstances and human-animal relationships. They *change the circumstances and relationships*. The robot affects what the farmer is

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expected to know and do; it affects farm layout, system and routine and it affects the farmer's behaviour and his/her relationships with their cows. AMS change farmer-cow relationships significantly, creating new possibilities for how cows are seen and known by the farmer. But the farmer has to make the most of the opportunities created by the robot. For many AMS users, AMS demand even higher levels of stockmanship and discipline than conventional milking. AMS are associated with renegotiating human-animal relationships on dairy farms, conceptualised in terms of a shift in 'situated' ethics. The complexities of this were discussed in conference presentations and in papers published in the Journal of the Royal Agricultural Society of England and forthcoming in Journal of Rural Studies.

3. Farmers using AMS *experiment and tinker* with robots and the farm system, trying to get the technology to work optimally in unique circumstances. It involves trying to understand the robot and what it can/cannot do, and trying to overcome some of its limits. Learning to live with the robots, as well as informal communication with other farmers and reference to online discussions, can take precedence over formal communication with manufacturers.
4. Farmers using AMS have to *learn to make use of the data* produced by the robot, and to build their work routines around data analysis and responses to what the data tells them. However, many feel overwhelmed and admit to using only a fraction of the data available. Alternative ways of ensuring better use of the data could usefully be explored by manufacturers.
5. Use of visual methods in researching human-cow-technology relationships in dairy farming has produced useful insights into the nature of these relationships. Visual methods led the researchers to focus on different *scales of analysis* – for example in following individual animals or watching individual moments of interaction between cows and robots and/or humans, observing the movement of a herd of cows around the cowshed, or situating the cows and cowshed amongst the wider farm environment. From a non-representational perspective, the researchers gained a multisensory encounter with the cows, robots and farm. Observing individual cows and groups of cows encouraged the researchers to begin to think about bovine experiences, interactions and welfare in new ways. Critical appraisal of these methods in symmetrically exploring human-nonhuman relations, alongside thinking about how to articulate what was observed in meaningful ways, was undertaken through a presentation at the *International Visual Studies Conference*.

e) Contributions to wider ESRC initiatives (eg Research Programmes or Networks)

If your project was part of a wider ESRC initiative, please describe your contributions to the initiative's objectives and activities and note any effect on your project resulting from participation. [Max. 200 words]

Not applicable

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3. Early and anticipated impacts

a) Summary of Impacts to date

Please summarise any impacts of the project to date, referring where appropriate to associated outputs recorded on the Research Outcomes System (ROS). This should include both scientific impacts (relevant to the academic community) and economic and societal impacts (relevant to broader society). The impact can be relevant to any organisation, community or individual. [Max. 400 words]

The research has produced a number of outputs and activities focused on generating impact for academic and non-academic audiences. A project website (<http://www2.hull.ac.uk/science/geography-1/research/livestockrobotics.aspx>) was developed and has been maintained to facilitate wide communication of the project's progress and findings.

1. Six conference papers have been presented at international and UK-based conferences (details available from the ROS). Internationally, these include the annual conferences of the American Association of Geographers, the Royal Geographical Society-Institute of British Geographers, the International Visual Methods Conference and European Society for Rural Sociology. Nationally, they include the British Animal Studies Network and Annual Conference of the Association of Social Anthropologists of the UK and Commonwealth. The project team also coordinated a paper session on human-animal-technology relationships at the RGS-IBG Annual Conference 2011. Several invited research seminars were given.
2. So far, two academic articles have been produced. One (*Recapturing bovine life: robot-cow relationships, freedom and control in dairy farming*) is forthcoming in Journal of Rural Studies. The other is published in the Journal of the Royal Agricultural Society of England (details available from ROS) aimed at a mix of academic and non-academic audiences.
3. The research concluded with an end-of-project seminar at the headquarters of the Royal Agricultural Society, Stoneleigh Park, Warwickshire, 17th October 2012. The seminar was titled *Dairy Cow Management and Welfare: What Difference Does Robotic Milking Make?* and was attended by around 25 people including manufacturers of robotic milking equipment and representatives of a range of institutions involved in dairy farming and attendees with expertise in the development of AMS, veterinary science and dairy cow nutrition. The event included a presentation and discussion of the research findings and presentations from guest expert speakers. The Seminar was followed by the publication of an end-of-project summary brochure and pdf (details available from ROS and project website) aimed at non-academic users, and this has been widely disseminated amongst those who have been involved in the research.
4. To facilitate wider public discussion of the issues raised by the project a Science Cafe event was held in Beverley, East Yorkshire (27th June 2012), titled *Cows milked by robots: the rights and wrongs of modern dairy farming*. Materials used are available from the project website. The event was well attended by a mix of people from

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farming and non-farming background and stimulated animated discussion on changes in dairy farming as well as on farming and food more widely.

b) Anticipated/Potential Future Impacts

Please outline any anticipated or potential impacts (scientific or economic and societal) that you believe your project might have in future. *[Max. 200 words]*

Anticipated future impacts will come from the following.

- Academic impact (on debates in geography, sociology and related disciplines, and the inter-disciplinary field of animal studies) from further papers developing the theoretical and empirical contributions of the research in novel directions. Papers will focus on: the situated ethics of AMS dairy farming; farmers' changing knowledge-practices in relation to robotic and information technologies; the potential for combining ethnographic and ethological techniques in researching human-nonhuman relationships; and the use of visual methodologies in research with nonhuman animals.
- Following the researchers' convening of a conference session on animals and technologies (Annual Conference of the RGS-IBG, 2011), a special issue of Journal of Rural Studies is in production. The issue will consist of 7 or 8 papers including one coming directly from this research, along with an editorial co-authored by the researchers.
- User group attendees at the end of project seminar expressed particular interest in issues to do with farmers' use of information. The researchers will attempt to engage the sector more widely via the farming press as further discussion of this topic seemed to be needed by the industry.

You will be asked to complete an ESRC Impact Report 12 months after the end date of your award. The Impact Report will ask for details of any impacts that have arisen since the completion of the End of Award Report.

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4. Declarations

Please ensure that sections A, B and C below are completed and signed by the appropriate individuals. The End of Award Report will not be accepted unless all sections are signed. Please note hard copies are **not** required; electronic signatures are accepted and should be used.

A: To be completed by Grant Holder

Please read the following statements. Tick **one** statement under ii) and iii), then sign with an electronic signature at the end of the section (this should be an image of your actual signature).

i) The Project

This Report is an accurate overview of the project, its findings and impacts. All co-investigators named in the proposal to ESRC or appointed subsequently have seen and approved the Report.	<input checked="" type="checkbox"/>
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ii) Submissions to the Research Outcomes System (ROS)

Output and impact information has been submitted to the Research Outcomes System. Details of any future outputs and impacts will be submitted as soon as they become available.	<input checked="" type="checkbox"/>
or This grant has not yet produced any outputs or impacts. Details of any future outputs and impacts will be submitted to the Research Outcomes System as soon as they become available.	<input type="checkbox"/>

iii) Submission of Data

Data arising from this grant have been offered for deposit with the UK Data Service.	<input checked="" type="checkbox"/>
or Data that were anticipated in the grant proposal have not been produced and the UK Data Service has been notified.	<input type="checkbox"/>
or No datasets were proposed or produced from this grant.	<input type="checkbox"/>