EIPWALES
Cydweithio er ffyniant gwledig
Collaborating for rural success

menter a busnes

European Innovation Partnership (EIP) Wales

Using IOT technology to improve slurry management on farms

Monitoring Attitude

September 2022

WCOLTD.
Organisational Development Consultants / Ymgynghorwyr Datblygu Sefydliadol
Llety'r Bugail, Foel, Welshpool, Powys, SY21 0NZ.
Tel: 01938 820434 / Mob: 07919 447434
wyninclover@hotmail.com

Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig:
Ewrop yn Buddsoddi mewn Ardaloedd Gwledig
European Agricultural Fund for Rural Development:
Europe Investing in Rural Areas
Llywodraeth Cymru
Welsh Government

Contents

Using IOT technology to improve slurry management on farms - Monitoring Attitude

Introduction

This is the overarching and final report in relation to the attitude monitoring element of an European Innovation Partnership (EIP) Wales project, undertaken in North Wales between autumn 2020 and summer 2022.

The research project itself was devised, delivered and monitored by Innovation broker Geraint Hughes of Lafan Cymru. The primary aim of the project was to investigate how Internet of Things (IoT) technology, utilising Long Range Wide Area Network (LoRaWAN) sensors can be used to improve slurry management and therefore add value to managing farms in Wales. More specifically, to enable land managers to make better informed decisions in terms of appropriate conditions for applying slurry, therefore making best use of the available nutrients whilst also minimising the risk of water pollution.

Following a thorough review of commercially available sensors and comprehensive field mapping; sensors were deployed on three project farms in late 2020 to measure: soil moisture, soil temperature, air temperature, rainfall and slurry store levels.

The project was devised to be driven by farmers and in particular the three farmers managing the project sites namely: Ceredig Evans, Aled Jones and Rhodri Owen. These three were instrumental in the establishment and development of the project and their involvement in and commitment to the research project and the attitude survey element was key to satisfactory data collection. Separate reports detailing the content of each of the four focus groups are available on request from the Innovation broker and shared at their discretion.

The original brief for the project included the involvement of an attitude monitoring analysis specialist. Their role was to undertake continuous participatory evaluation of the attitudes of participating farmers towards usability, durability, accuracy, clarity of information and reliability of the equipment. This longitudinal study was conducted through four focus groups across the life of the project, supplemented by regular questionnaires completed by all three participants. This report constitutes an overview of the attitude survey element of this project as outlined by the appointed attitude analysis specialists WCO Ltd. Organisational Development Consultants.

Wyn Owen MSc DipPsych NSch
WCO LTD.
Director/Cyfarwydd wr

Methodology

The methodology for the attitudinal study comprises a longitudinal mixed methods approach. Data was collected through two primary sources namely focus groups (four in total as stipulated in the project brief) and also a standardised questionnaire completed several time across the life of the project by the three farm managers.

The questionnaire data was collated utilising a longitudinal mixed measures questionnaire which all three farmer participants were invited to complete at regular intervals throughout the project. The questionnaire was developed from a version previously successfully utilised by the author for evaluating Farming Connect's Agrisgôp programme. This evaluation is referred to in the full EIP application as an example of how attitude/sentiment changes can be recorded. The specific generic questionnaire used for this project, was adapted and developed in conjunction with the EIP Innovation broker and following the practical trialling of several versions. A copy of the questionnaire can be found at Appendix 1.

The four focus groups as stipulated in the briefing document were all held over Zoom and facilitated by Wyn Owen. All four focus groups were held at lunchtime with each lasting an hour. The basic and overriding methodology utilised was that of market research focus groups, designed to identify participants' feelings, perceptions and thoughts about a particular product or range of products. The questioning protocol was predetermined and followed a logical sequence intended to mimic a natural exchange with the aim of collecting rich qualitative data. In line with guidelines for focus groups, abrupt changes of direction or topic were avoided and all participants were encouraged to contribute equally. Furthermore, the flexible design enables an experienced facilitator to be agile and guide the discussions in relation to the content and also the tone, body language and behaviour of the group. (The balance, 2020)

In addition to the focus group methodology, Action Research (AR) methodology was also used particularly during focus groups two and three with the qualitative data collected in the first and last focus groups primarily utilised as snapshots in time of the beginning and end of the project. According to Robson & McCartan (2017), the primary purpose of AR methodologies is to influence or change some aspect of the focus of the research through:
Firstly - Improvement of practice of some kind
Secondly - the understanding of a practice by its practioners
Thirdly - the improvement of the situation in which the practice takes place

AR Protagonists maintain that practitioners (in this case the farmers and the stakeholders involved in the focus groups) are more likely to make better decisions and engage in more effective practices if they are active participants in the research. The premise of AR is triple loop learning as outlined in Appendix 2.
AR is typically viewed as a cyclical, spiral or corkscrew process which involves:

- planning a change
- acting and then observing what happens following the change
- reflecting on these processes and consequences
- planning further action and then if necessary - repeating the cycle

Utilising concurrent embedded strategy in order to support the quantitative analysis, qualitative analysis of the second half of each questionnaire was also undertaken utilising NVivo to code that data. Concurrent embedded strategy involves the simultaneous collection of both quantitative and qualitative data with the primary method (qualitative) guiding the findings and the secondary method (quantitative) being nested or embedded within the predominant method (Creswell, 2009). The extremely small sample size (n=3) precludes any statistical analysis of the quantitative data, so the principle methodology for analysis is qualitative and draws upon data from the questionnaires and predominantly the focus groups.

Results

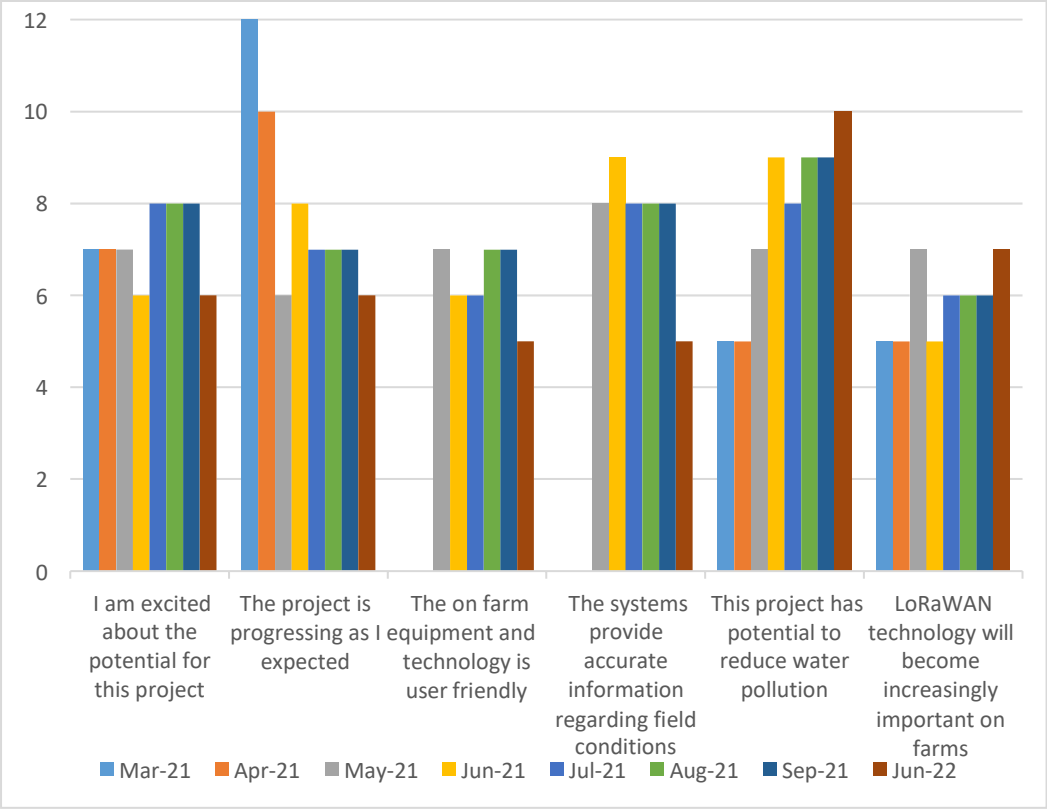


Fig 1. Quantitative questionnaire responses with lowest numerical scores indicating *agree with statement* and higher scores indicating *disagree*.

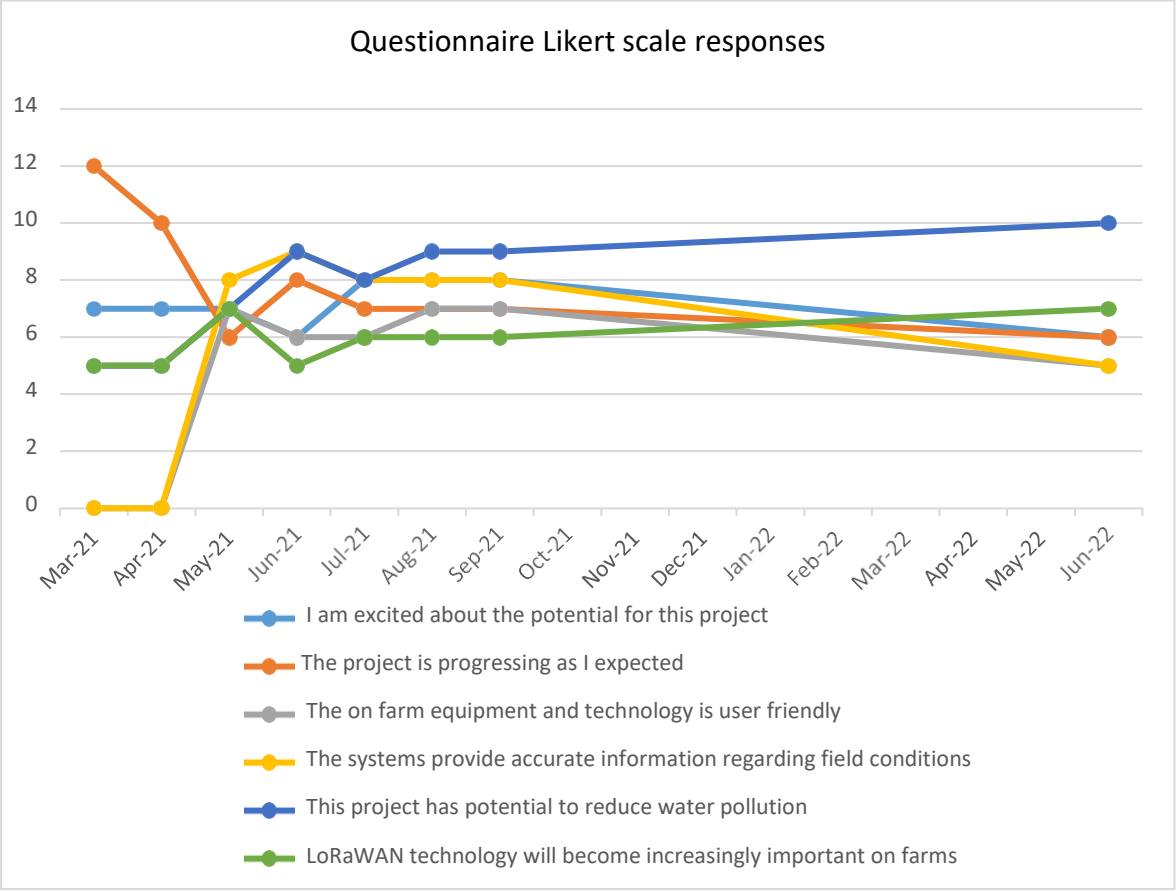


Fig. 2. Same data as Fig. 1 showing general tendency to agree more with the statements as the project progressed.

Fig. 3. Word frequency first three questionnaires – March, April and May 2021

Fig. 4. Word frequency second three questionnaires – June, July and August 2021

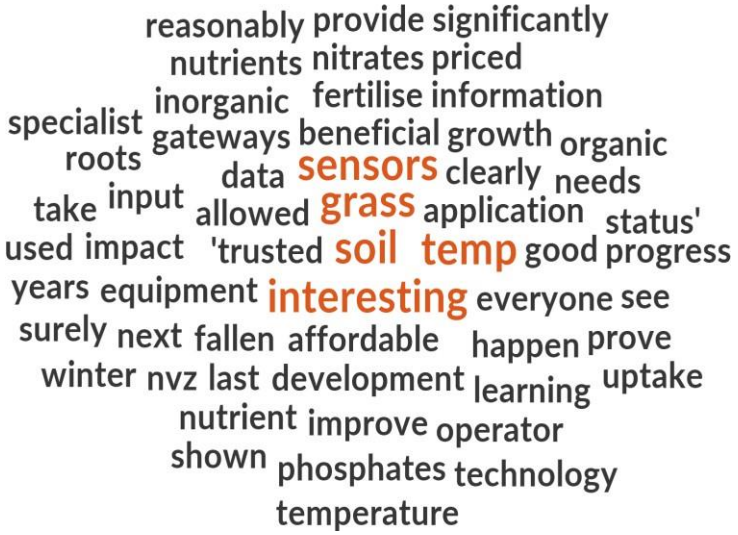


Fig. 5. Word frequency final two questionnaires – September 2021 and June 2022

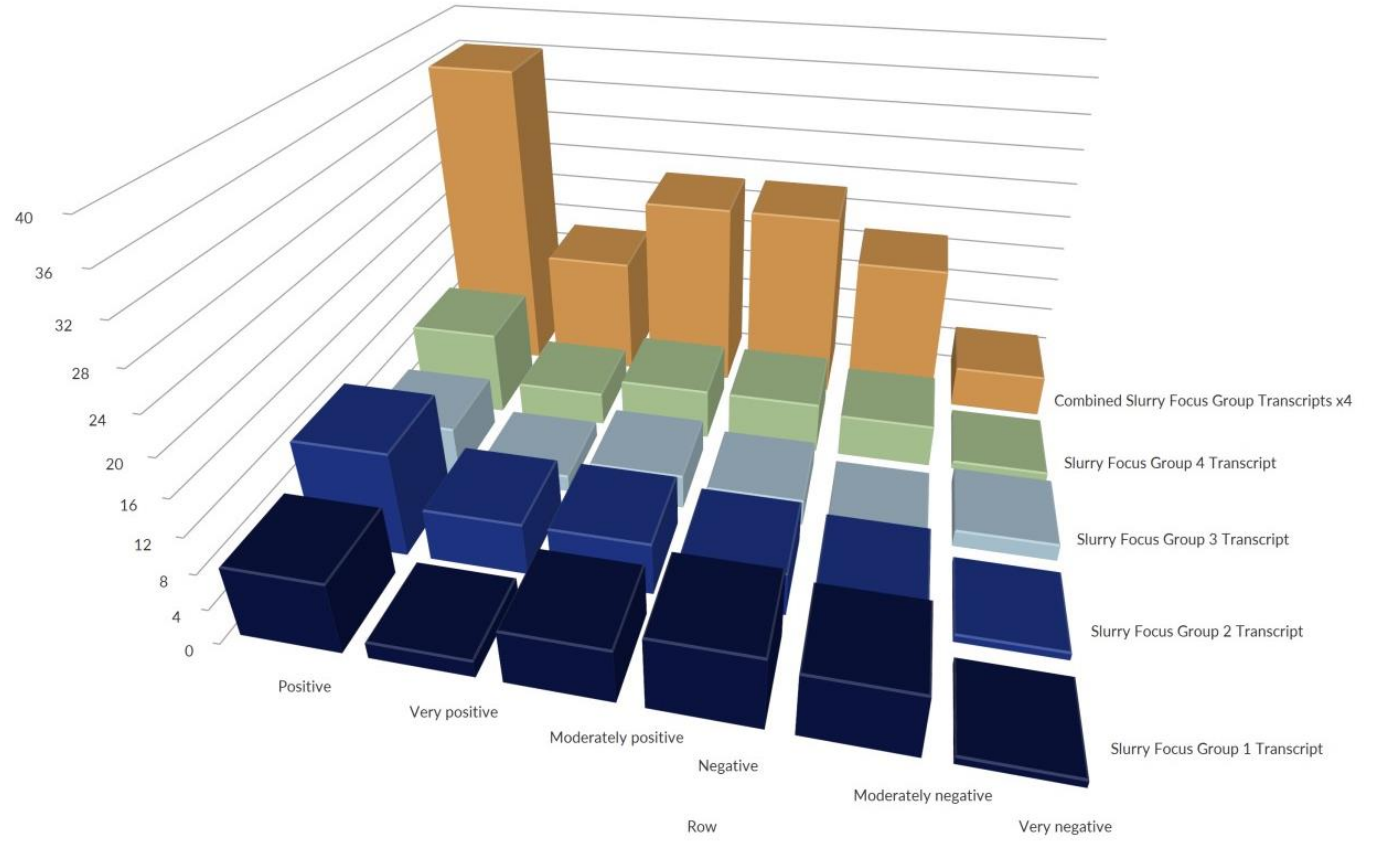


Fig. 6: Graph plotting the four focus group transcripts combined and individually against sentiment/attitude of the sentence content.

	Positive	Very positive	Mod. positive	Negative	Mod. negative	Very negative
1 : Slurry Focus Group 1 Transcript	**8**	**2**	**6**	**8**	**7**	**1**
2 : Slurry Focus Group 2 Transcript	**12**	**6**	**6**	**5**	**4**	**1**
3 : Slurry Focus Group 3 Transcript	**6**	**2**	**4**	**3**	**1**	**2**
4 : Slurry Focus Group 4 Transcript	**10**	**4**	**6**	**6**	**5**	**1**
5 : Combined Slurry FG Transcripts	**36**	**14**	**22**	**22**	**17**	**5**

Fig. 7: Table plotting the four focus group transcripts combined and individually against sentiment/attitude of the sentence content.

	Positive	Negative
1 : Slurry Focus Group 1 Transcript	**16**	**16**
2 : Slurry Focus Group 2 Transcript	**24**	**10**
3 : Slurry Focus Group 3 Transcript	**12**	**6**
4 : Slurry Focus Group 4 Transcript	**20**	**12**
5 : Combined Slurry FG Transcripts	**72**	**44**

Fig. 8: Table plotting all focus group transcripts displaying total positive v negative attitudes coding references.

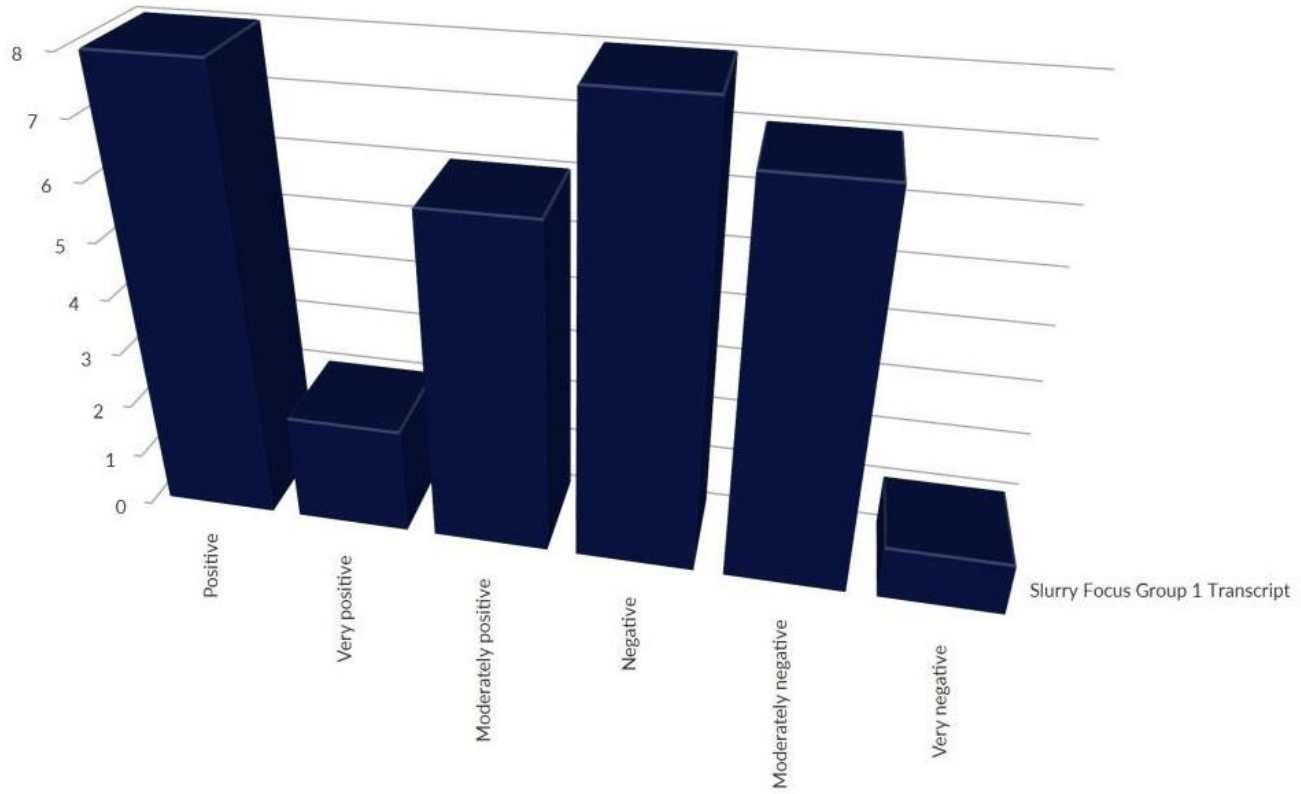


Fig. 9: Graph plotting focus group 1 transcript sentiment/attitude of the sentence content.

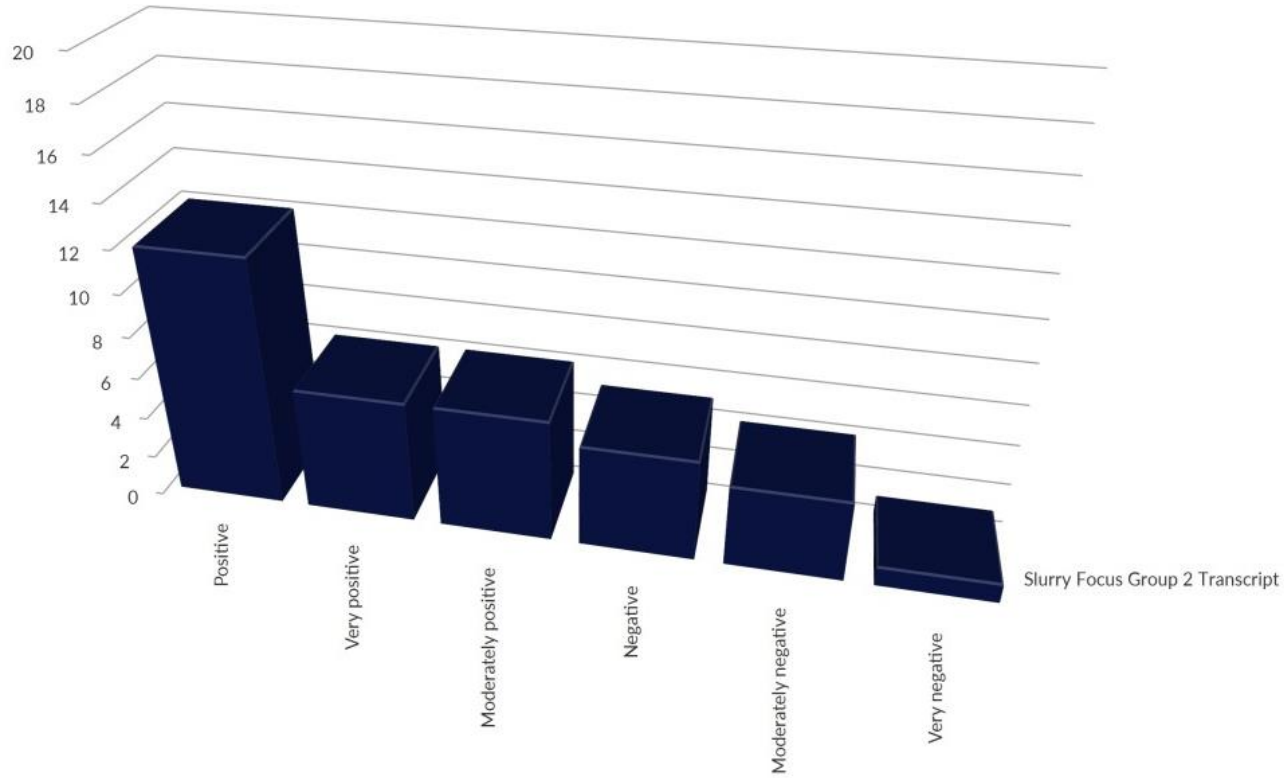


Fig. 10: Graph plotting focus group 2 transcript sentiment/attitude of the sentence content.

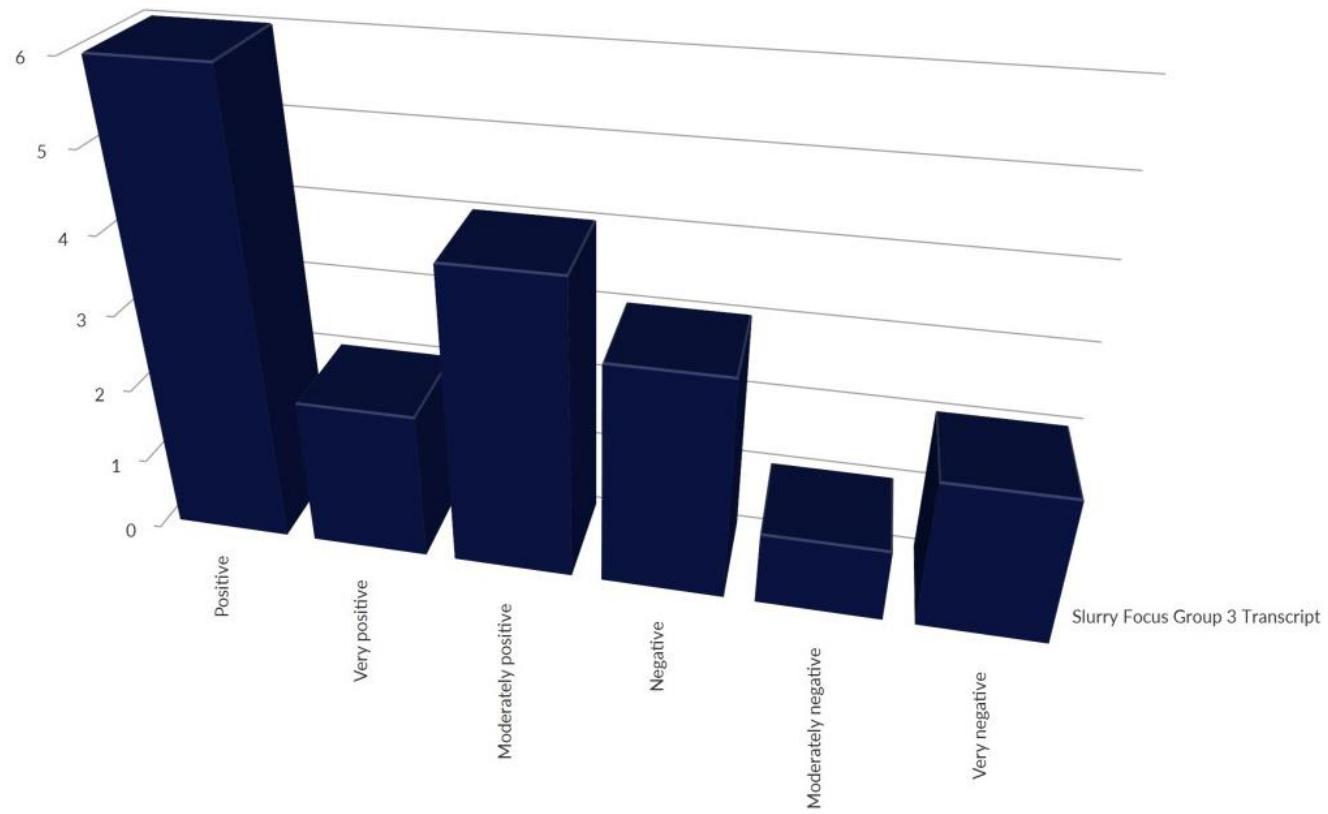


Fig. 11: Graph plotting focus group 3 transcript sentiment/attitude of the sentence content.

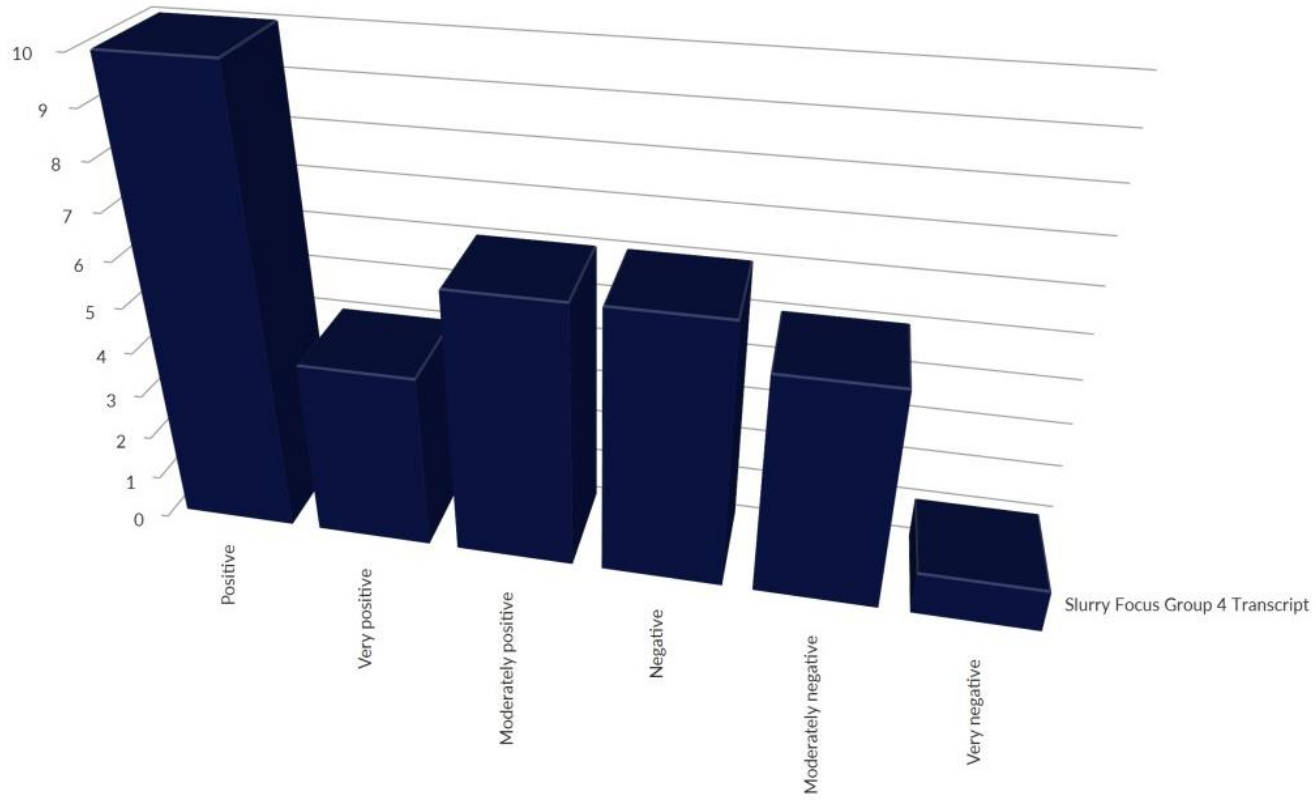


Fig. 12: Graph plotting focus group 4 transcript sentiment/attitude of the sentence content.

Discussion

During the 21st century, psychologists have become increasingly interested in the concept of attitude and its importance in influencing change. Williams, Chen & Wegener (2010) report that as people are continuously bombarded by information, they naturally develop a mechanism for filtering out information that isn't applicable or important. However, a message that promises to deliver a benefit in terms of control, self-esteem, belonging or improved existence in some way; may be selected through biased information processing and retained and reinforced as a positive benefit to that individual. Fundamentally then, an initial or early developed positive attitude towards a particular innovation will increase the likelihood of that innovation being adopted and utilised.

An attitude has been described as *"an evaluation of an object of thought".* Bohner and Dickel (2010) concur with Williams et al (2010) that attitudes remain amongst the most important and active fields in social psychology. They also purport that attitudes are closely related to bodily sensations such as body temperature (e.g. give a warm feeling), that individuals are motivated to seek high quality information if their attitude is positive and that explicit measures of attitude are likely to result in behaviour which is more controlled and deliberate.

Encouraging farmers worldwide to adopt digital technologies has become a policy priority, driven by the UN's Food and Agricultural Organization (FAO). A study considering how best to positively influence the attitudes of farmers in Taiwan to smart agriculture including IoT, gives some insight into the psychological factors which drive the adoption of smart technologies. Chang, Wang & Liou (2020), concluded that the key factors affecting successful adoption were: adequate knowledge, adequate initial information, awareness and a positive perception of the practical value of the technology.

In a longitudinal study claimed to be the first of its kind, the authors considered whether attitudes and beliefs towards using information technology (IT) influence people's willingness to use IT and whether that attitude changes over time (Bhattacherjee & Premkumar, 2004). They found that although attitude perceptions may fluctuate over time, the usefulness of the IT is the strongest driver of attitude and that attitude perceptions are more likely to change during the earlier stages of exposure to the new technology. Therefore, initial positive interaction with the IT is the most likely predictor of a positive attitude towards that particular technology.

A survey of UK sheep farmers' attitudes by Kaler & Ruston (2019), utilised recorded interviews subsequently transcribed and analysed using NVivo, to gain an understanding regarding why the participants resisted utilising EID related precision technology on their farms. They found that the farmers largely reported alternative beliefs that using technology threatened their identity as good stockmen, that the technology was expensive and difficult to use, and couldn't replace traditional hands-on stockmanship. In conclusion, the authors suggest that in order to maximise positive attitudes and early adoption of technology; farmers needed to be involved from the early stages of development to give them greater control whilst developing the technology as a complementary aid to traditional practices rather than a means to make more money.

Having considered the current background in this arena and moving onto the slurry EIP Wales project data, although the extremely small sample size (n=3) precludes any statistical analysis of the quantitative data from the questionnaires, there is a non-significant positive direction in attitude across the study. Figures 1 and 2 show increasing agreement with the first four statements in the questionnaire relating to *potential, progress, user friendliness and accuracy*. The responses indicate that agreement with the last two statements relating to *water quality and increasing importance of LoRaWAN* generally decreases across the life of the project.

This is generally supported by the comparatively large amount of qualitative data from the questionnaires when considering word frequency (See: Figs 3, 4 and 5) with the most frequently used words across being primarily positive with a notable absence of negatively themed words e.g. problem, concern, disadvantage or poor.

Most notably the qualitative focus group data which is considerable, strongly supports the premise that the participating farmers' attitude becomes increasingly positive as the project develops. Utilising the matrix coding function in NVivo to cross tabulate the focus group transcripts with sentiment/attitude, yields some interesting positive outcomes in terms of attitude when plotted across the life of the project.
It can be seen from Figure 6 that the combined content of all four focus groups is overall; considerably more positive than negative as also shown in tabular form in Figure 7.

Combining the total amount of positive sentiments (*positive* + *very positive* + *moderately positive*) versus total negative sentiments (*negative* + *very negative* + *moderately negative*) across the life of the project (Figure 8), makes it easier to appreciate, that the matrix coding found many more positive sentiments in total.
When considering the change in attitude across the life of the project as represented per focus group in figures 9-12, the first focus group transcript has an equal total amount of positive and negative sentiments. Interestingly, coding for focus group two transcript, results in more than double the amount of positive responses than negative; however there isn't the scope in this report to speculate as to why this difference is so substantial. Continuing the theme, both focus groups three and four transcripts have notably more positive than negative responses as indicated by the matrix coding.

Summary

- According to analysis of the focus group transcripts, the farmer participants' attitude to the technology in this project increased from being neutral (equal positive and negative) to considerably more positive than negative across the life of the project (from first to last focus groups)

- The biggest change towards a more positive attitude occurred between the first and second focus groups

- Both the quantitative and qualitative data from the questionnaires generally supports the data from the focus groups

- Review of previous work in this field suggests that positive early attitudes as recorded here, are likely to encourage adoption of the technology (Chang, Wang & Liou, 2020; Bhattacherjee & Premkumar, 2004) as is early farmer involvement in the trialling of the equipment (Kaler & Ruston, 2019)

- Even though the primary focus of this research was change in farmers' attitudes, the author observes that the involvement of and input from other participants (e.g. individuals from organisations with relevant technical expertise and from interested agencies) was extremely important and useful to the efficacy of the focus groups and the project overall

Acknowledgements

Sincere thanks are due to the three farmer participants in this project: Ceredig Evans, Aled Jones and Rhodri Owen; for giving their expertise, their farms and a considerable amount of their time so willingly and fully to this project. Gratitude is also expressed to anyone else who was involved in any way in the focus groups or the data collection and to Rob Sheperd for his substantial contribution to the technical element of this project, without which this attitude survey would have been much more difficult.

Finally and most crucially; Thanks to Geraint Hughes and Meinir Jones for their guidance, assistance, expertise and patience throughout the project. Diolch yn Fawr.

References

Argyris, C. (1991). Teaching Smart People How to Learn. *Harvard Business Review.* Volume 4, No. 2.

Bhattacherjee, A. & Premkumar, G. (2004). Understanding Changes in belief and Attitude towards Information Technology Usage: A theoretical Model and Longitudinal Test. *Management Information Systems (MIS) Quarterly, 28: p229-254.*

Bohner, G. & Dickel, N. (2011). Attitudes and Attitude Change. *Annual Review of Psychology, 62: p391-417.*

Chuang, J., Wang, J. & Liou, Y. (2020). Farmers' Knowledge, Attitude, and Adoption of Smart Agriculture Technology in Taiwan. *International Journal of Environmental Research and Public Health, 17:p1-8.*

Creswell, J.W. (2009). *Research Design – Qualitative, Quantitative and Mixed Methods Approaches.* (3rd Ed.). London: Sage.

Kaler, J. & Ruston, A. (2019). Technology adoption on farms: Using Normalisation Process Theory to understand sheep farmers' attitudes and behaviours in relation to using precision technology in flock management. *Preventative Veterinary Medicine, 170: p1-8.*

Robson, C. & McCartan, K. (2017). *Real World Research.* (4th Ed.) New Jersey: Wiley

The Balance (2020), *What is a Market Research Focus Group? Accessed 24/11/2020 from: https://www.the balancesmb.com/what-is-a-market-research-focus-group-2296907*

Williams, K.D., Chen, Z. & Wegener, D. (2010). Persuasion after ostracism – Need based influences on persuasion. In Forgas, J.P., Cooper, J. & Crano (Eds.), *The Psychology of Attitudes and Attitude Change.* (p.199-213). London: Taylor & Francis Group

Name :
Farm name:
Date :

SLURRY EIP QUESTIONNAIRE

Please circle a number from **1** to **9** to indicate how strongly you agree or disagree with each statement:

I. I am excited about the potential for this project
strongly agree **1 2 3 4 5 6 7 8 9** strongly disagree

II. The project is progressing as I expected
strongly agree **1 2 3 4 5 6 7 8 9** strongly disagree

III. The on farm equipment and technology is user friendly

strongly agree **1 2 3 4 5 6 7 8 9** strongly disagree

IV. The systems provide accurate information regarding field conditions
strongly agree **1 2 3 4 5 6 7 8 9** strongly disagree

V. This project has potential to reduce water pollution
strongly agree **1 2 3 4 5 6 7 8 9** strongly disagree

VI. LoRaWAN technology will become increasingly important on farms
strongly agree **1 2 3 4 5 6 7 8 9** strongly disagree

Please write three sentences regarding your current view of the project (maximum 75 words)

_____

_____

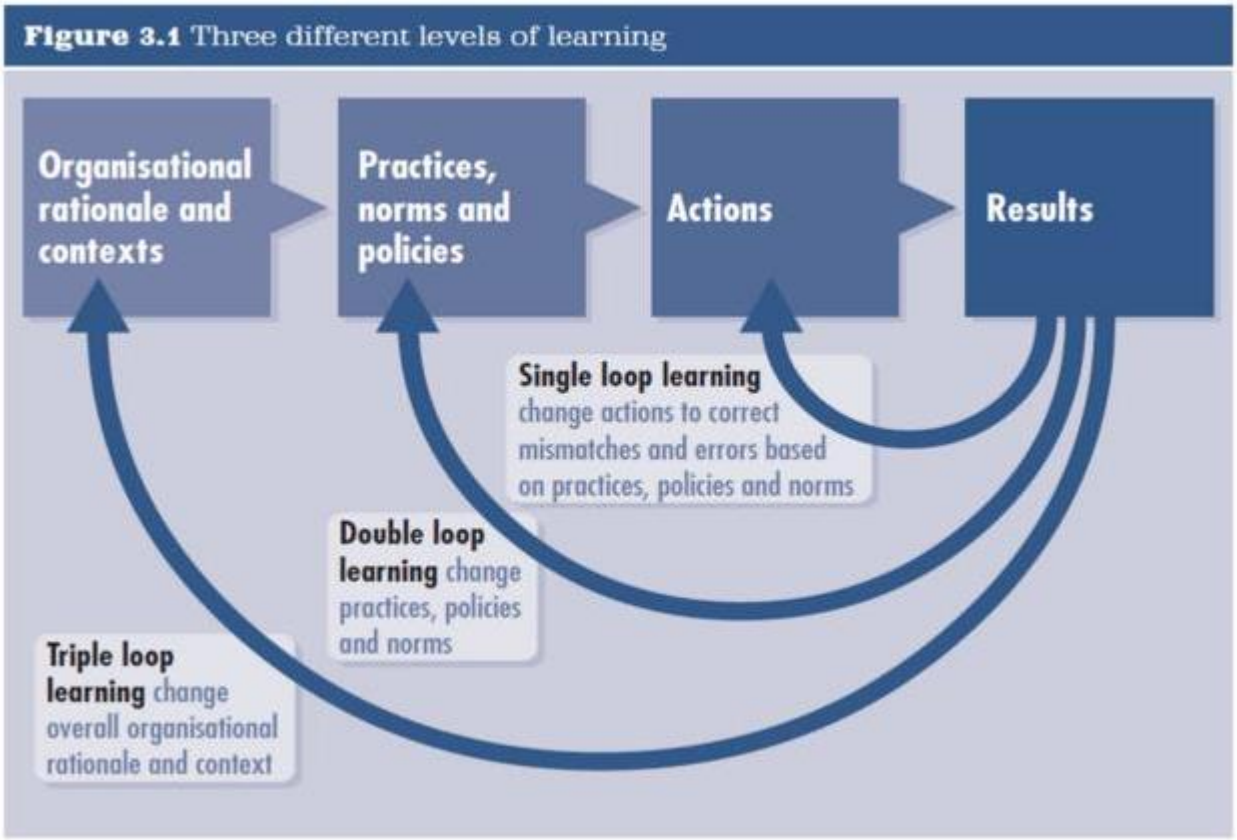
_____

_____

_____

_____

Appendix 2: Triple loop learning model



Model of triple loop learning as used in Action Research. Attributed to Argyris (1991).