Reflections on disease control measures for sheep keepers, following interventions on the islands of Lewis and Harris

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Executive Summary

Following on from awareness raising workshops in 2022, a second set of six in-person workshops on disease control, focusing on roundworm and sheep scab, were held with crofters on Lewis and Harris (L&H) in November 2023. A supplementary online workshop was held in January 2024. The 2023/24 workshops explored current disease control measures, practices crofters intend to implement in the near future and those that would be challenging to implement. Also discussed were: the benefits of collaborative working; other diseases that might benefit from collaborative action; barriers to island livestock disease control, and use of decision support tools. Expert talks were given on roundworms and sheep scab, and an update was provided on the mobile dipping campaign.

Findings

Collaboration

The sheep scab intervention (in particular dipping) has led to renewed understandings and forged new working relationships. The social capital built has allowed crofters to recall the advantages of working together, whilst showing newcomers what collective action can do. Crofters hope this is the start of a journey that can lead to a sheep scab free island flock.

Additional sheep diseases

Although the sheep scab intervention has been going well it has not yet influenced the control of other diseases. When discussing other parasitic infections, crofters showed interest in joint management, but sheep scab is a priority. As the collaborative way of working gathers momentum, the control of other diseases might be considered. It will be interesting to follow this journey to identify on-going benefits of returning to traditional ways of working in the townships and communities. Providing information on other diseases, and messaging on recommended practices may highlight areas where collaboration could be beneficial.

Island control

Island-wide disease management is something crofters were keen to engage with although more information is required to inform future decisions. Several barriers were discussed, including: Funding for necessary infrastructure on the island, logistical concerns over where infrastructure would be situated, the need to engage with crofters with small numbers of sheep, how to achieve island-wide agreement, support for additional private vet roles on the island, and policy and legislative changes to support island-wide livestock health management, similar to legislation for Shetland Animal Health Scheme (SAHS).

Decision support tools

Decision support tools were not commonly used. Many believed that the advice would not be specific enough. The Sustainable Control Of Parasites of Sheep (SCOPS) *Nematodirus* forecasting map and "FEC check" were selected as tools crofters would be keen to trial. Paid services were not welcome. A few crofters said they would be interested in an interactive planner with targeted notifications that identified actions they could undertake.

Feedback on disease control measures

Crofters were asked to indicate which disease control measures they currently use, which they are planning to start using, and which might be challenging to implement. Easier to implement measures

are currently in place, whilst more time consuming to set up, costly, or resource rich measures are deemed either impractical or out of reach of the small crofting enterprises. Measures must be tailored to the crofting system and ideally co-designed with the crofters and associated institutions, e.g., the L&H Sheep Producers Association, The Scottish Crofting Federation and the Crofting Commission.

The definition of closed flock

There was confusion about what a closed flock was, however, some crofters could see the benefits. Barriers to the development of closed flocks included, the regular use of common grazing and sharing equipment and infrastructure. Some crofters said they kept closed flocks, but only in relation to female animals. Tups are often shared and moved, increasing the risk of disease spread. One participant suggested that L&H could have an 'island flock', but this is currently hampered by a lack of community and island level coordination.

Fencing: management of disease and/or stock movements

Most fences were described as in a poor state of repair. Fences are used for stock control, not biosecurity. Participants noted that when crofters seek to improve fences, they prioritise fields used for lambing and tupping. Crofters felt that it was expensive to repair and replace fences, and there were few contractors willing to take on the work. A participant questioned the role of fencing within a system that uses communal grazing. However, future funding for the upgrade of fencing at the township level could have significant impacts on disease control.

Messaging

Messages need to be simple and targeted, giving advice and clear, precise, practical measures that can be implemented easily. Crofters suggested that the format should be varied. There is no one format that is suitable for all. The learning preferences of people, with diverse backgrounds, should be taken into consideration. Care needs to be given when disseminating information as some areas and communities can be difficult to reach, whilst others have preferred ways of receiving information. Word of mouth is still one of the best ways to communicate on the islands.

Introduction

The workshops held in 2023/24 were part of a longer-term project funded by the Scottish Government exploring sheep disease control on Lewis and Harris (L&H). This research is one part of a larger transdisciplinary project: Co-designing and implementing best-fit farming practices (COMBINE). This element of the COMBINE project aims to explore how to extend best-fit practices to address disease control in lower production systems, focusing on livestock production in remote and island settings. The research is theoretically grounded in the 'Triggering Change Model' (TCM) of farmer decision-making [1]. The TCM draws on social psychology [2] and substantial empirical evidence [3] to demonstrate that major changes in farm trajectory occur largely in response to 'trigger' events or circumstances. The sheep scab and roundworms interventions will enable both transformational and incremental changes. Incremental changes will be encouraged by collaborating with farmers and industry actors to develop approaches that work with farmers' path dependencies, enabling them to move more quickly along their existing pathway. The challenge of enabling transformational changes will be addressed by working at key moments where path dependencies can be broken. The work undertaken as part of COMBINE is closely aligned with the Scottish Government-funded sheep scab control project on Lewis & Harris and Preparing for Sustainable Farming initiative, which seek to work closely with the farming and crofting communities to enable them to learn about how their work impacts on climate and nature and how the use of Animal Health and Welfare Interventions can lower greenhouse gas emissions and increase efficiencies. The project is ongoing, but the timeline (Fig 1) summarizes the main activities that will be described in more detail in this report.

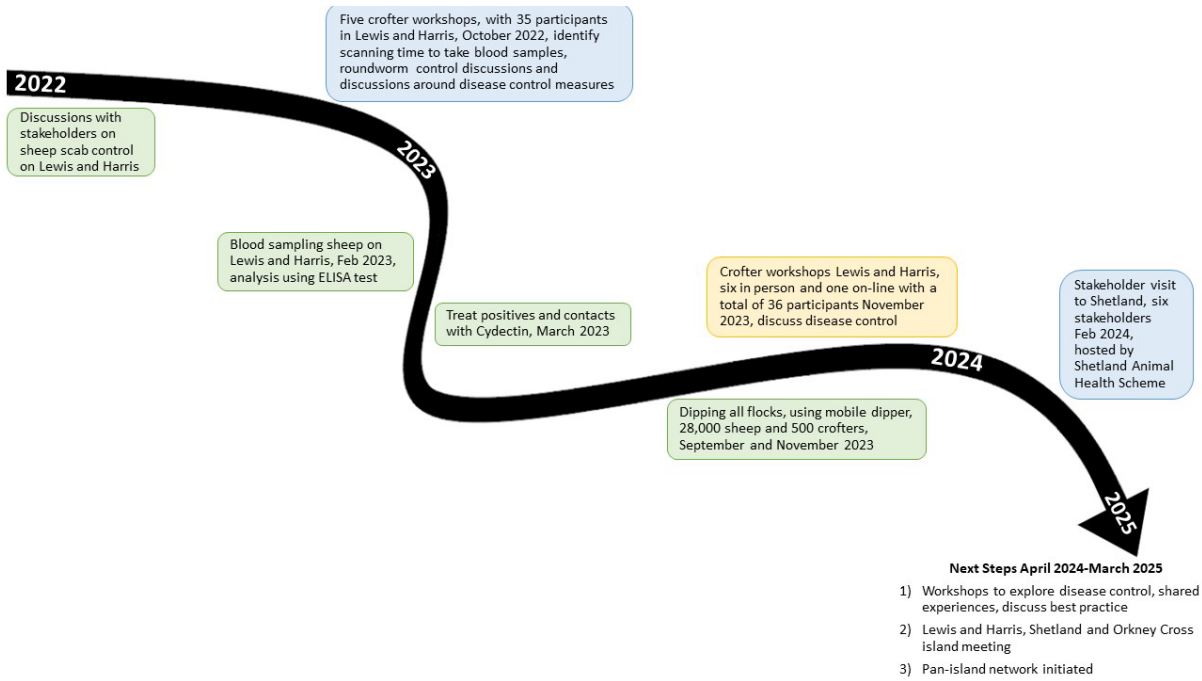

Figure 1: Timeline of activities supporting disease management on L&H

Background

Initially, five in-person workshops were held in 2022 to discuss biosecurity on crofts, current control practices for sheep scab and roundworms, and the potential for community-level programs. How to operationalise the blood testing of island flocks for sheep scab was discussed and agreed.

Findings from the 2022 workshops

The main findings were,

- The term 'biosecurity' was not largely recognised, although the participants described good biosecurity practices, showing a disconnect between practice and terminology.
- Best practice biosecurity measures were not in place, instead crofter were conducting 'best-fit' measures that better suited the context of crofting.
- Awareness of roundworms and sheep scab, available diagnostic tests, and control measures varied.
- Few participants had heard of the industry body, "Sustainable Control Of Parasites in Sheep" (SCOPS).
- Leisure users and wildlife were seen as risks to disease control and the mitigation of these risks were discussed.

Blood testing and sheep dipping

Following on from the 2022 workshops, collaboration between the Moredun team and island coordinators enabled blood samples from 105 flocks to be taken and analysed for sheep scab during the gather for routine scanning in February 2023. Three flocks were visibly identified as sheep scab positive, and a further 17 flocks were serum positive using the sheep scab ELISA test, amounting to 19% of those tested. Due to the proximity to lambing, the decision was made to use injectable MLs for the treatment of positive cases, flocks from contiguous properties and those in the fanks at the same time as affected flocks. Treatment (Cydectin 2%) was provided by Zoetis Animal Health Ltd, who also provided training in its use. Due to the emergence of ML resistance, free follow-up blood testing was provided. Two cases of 'lack of efficacy' were identified, where the treatment had been poorly applied. In both cases follow-up treatment with an OP plunge dip was arranged, and efficacy was confirmed through further testing. In conjunction with the Lewis and Harris Sheep Producers' Association (LHSPA), a decision was made to bring a mobile contract dipper to the island to focus on identified target areas. However, due to the huge amount of interest in the project from crofters across L&H, it was decided to expand this effort to an island-wide coordinated dipping campaign. This resulted in ~400 crofters being recruited to the project and crofters and local coordinators working closely together to effectively dip ~30k sheep across the island during September, October & November 2023. This has had a significant impact on the prevalence of disease in the island flock and was followed up with further testing to ensure treatment efficacy and to mop up any cases in flocks that did not participate in the dipping campaign. In addition, further testing and/or treatments have been provided for hoggs returning to the island in the spring from their overwintering pastures. This was undertaken to prevent the re-introduction of scab with returning animals, which are often overwintered in high-risk areas for sheep scab, i.e., the North East of Scotland. The plan is now to repeat these efforts in the autumn of 2024, with further efforts over the summer months to recruit more crofters to the project.

Roundworm management

Training was given on how to perform and analyse a faecal egg count (FEC). Crofters showed an interest in carrying out their own FEC. The Moredun team secured funding for two FECPAK instruments (Techion Ltd) which were provided with consumables and technical support for 2 years for use across L&H, funded by Livestock Health Scotland (LHS).

Case study diseases

The project focuses on two case study parasites of sheep, sheep scab and roundworms.

Sheep scab

Sheep scab, caused by infestation with the ectoparasitic mite *Psoroptes ovis*, is highly contagious, and represents a major welfare and economic concern for the sheep keepers throughout Scotland. Control relies on injectable anthelmintics (macrocyclic lactones (MLs) and organophosphate (OP) plunge dips. However, recently reported resistance to MLs suggests OPs might become the only therapeutic method of control in time. Scab is endemic in the UK and is a notifiable disease in Scotland under the Sheep Scab Order (Scotland) 2010. Estimates show that the disease costs the UK sheep sector £80-200 million per annum. The recent development of a blood test allows the identification of sub-clinical outbreaks, changing the way disease control is approached. Collaborative disease control at community and island levels, e.g., via collaborative dipping, combined with diagnostic sampling and testing of incoming livestock, can reduce the spread of scab within and between flocks.

L&H predominantly consist of crofting communities. Sheep movements occur within and between the islands and the mainland. The introduction of tups and returning of overwintering lambs from the mainland present major risks to the control of disease.

The project started with a pilot phase, which included serological testing to identify areas for targeted treatment and crofter meetings which identified a strong desire to achieve better sheep scab control. Treatments and advice were provided to all affected flocks and follow-up testing was used to ensure that the treatments were efficacious. Further funding from SG, facilitated an island-wide coordinated dipping campaign in 2023. This has led to significant reductions in the prevalence of sheep scab and a further round of testing and coordinated dipping is planned for 2024 (funding pending). The project has also facilitated testing and/or treatment of overwintering hoggs to ensure that sheep scab is not re-introduced.

Roundworms

Roundworms are found throughout the UK and threaten the health, welfare, and productivity of sheep farming. Commonly controlled using anthelmintics (wormers), the development of resistance to these compounds and variation in the epidemiology of roundworms infections, resulting from changes in climate and farm management, are making the sustainable control of these parasites more challenging. Best-practice recommendations for sheep have been set out by the industry advice group SCOPS. These are aimed at producers and are freely accessible online. Roundworm biosecurity practices have been designed to prevent the introduction of anthelmintic resistant worms with new and returning stock. Due to the prevalence of resistance within the UK national flock, the “gold-standard” is to yard animals for 48 hours, treat them with at least one of the new anthelmintic drugs

(Zolvix™ or Startect™) and inject with moxidectin. Producers are advised to isolate animals for 3 weeks and conduct a faecal egg count 10-14 days after treatment to confirm treatment efficacy.

Understanding keepers' knowledge and attitudes to roundworm risk, available control options and how treatments can target multiple disease-causing agents is important and highlights where knowledge exchange efforts should be targeted. Gathering reflections from island livestock keepers will help identify gaps in knowledge, areas of concern, and challenges encountered to parasite control. Identifying the challenges faced by crofters in implementing current recommendations within remote and island settings highlights the need for tailored advice and will inform the development and dissemination of future messages.

Method

Six workshops were held across L&H in the Outer Hebrides (Figure 2) over 3 days in November 2023. Locations were selected based on sheep scab hotspots identified from blood sampling. Five locations had been visited during the 2022 workshops, and an additional location in Harris was added to target new audiences. The locations were

- Ness (n = 6 participants)
- Balallan (n = 6 participants)
- Bragar (n = 7 participants)
- Tal na Mara (South Harris) (n = 6 participants)
- Harris Hotel (North Harris) (n = 4 participants)
- Stornoway (n = 5 participants)

Figure 2 Map of the Islands of Lewis and Harris

Participants read an information sheet, signed a consent form, and registered their attendance prior to participation in the workshop. Information was shared and discussed in plenary, participation poll clickers were used to anonymously collect votes to posed questions, and data was collected via interaction with posters, written sticky notes, researchers field notes and audio recordings.

Participants were asked to introduce themselves giving details of sheep numbers and their historical sheep keeping activities. Some were new to sheep keeping, but others had kept sheep for many years and were able to describe traditional ways of life that had been changing in recent years.

During the workshops participants were asked to reflect on the following areas:

- Whether the recent sheep scab interventions (i.e., blood testing and sheep dipping) had made a difference to their management of sheep disease
- Collaboration at community level
- Other sheep diseases they might seek to control
- Barriers to island-wide disease control
- The availability and use of decision support tools
- Messaging content and formats that would be useful to the islanders

Crofters were presented with a list of practices for sheep disease control and asked to indicate which they (1) currently use, (2) plan to implement in the near future, (3) might consider in the far future, and (4) would be unable to implement. Practices were divided into physical properties, education and training, 'knowledge on the crofts', and disease treatments (see Annex 1 for details).

Interest had been shown during the 2022 workshops in the systems that Shetland uses to keep their island flock disease free (including control of sheep scab and Ovine Pulmonary Adenocarcinoma (OPA)). It had been hoped to take six islanders (representing key stakeholder roles) to Shetland to gain insight into the procedures used. Unfortunately, the islanders' flights had to be postponed until the following year. However, the research team managed to visit and captured 360-degree footage of the Shetland Livestock disease control procedure. A virtual tour was developed (Figure 3) to show the procedure with video and embedded resources to help inform viewers of the infrastructure and process used to protect the Shetland flocks from imported disease. A demonstration of this virtual tour was given at the most recent workshops.

Figure 3: Shetland disease control virtual tour 2023

https://virtualtours.hutton.ac.uk/shetlandlivestockvisit/

Expert talks were provided by Moredun team members on disease control of sheep scab and roundworms, including past, ongoing and future interventions.

A supplementary online workshop was held in January 2024 with three individuals unable to attend the in-person workshops. These participants keep greater numbers of sheep and were considered key 'expert' contacts involved in the logistics and coordination of crofters on the islands. The online workshop followed an abbreviated version of the in-person workshop, focusing on the discussion questions and disease management practices.

Results

Collaboration

The sheep scab intervention has demonstrated what a successful collaborative action looks like, and how to achieve collective disease control. Crofters described the experience positively, saying that being part of the dipping campaign gave them a *'good feeling'*. They were pleased with the effort that everyone was willing to go to ensure all sheep in an area were treated, with one participant saying, *'many hands make light work'*. Many described the number of people involved, the effort of engaging the whole community, and how everyone was mobilised. One crofter said they felt they had *'gained respect by bringing their sheep to be dipped'*. People were surprised at the level of interest that had been generated and that buy-in for the dipping was greater than they had expected. One crofter commented *'whole families including children were present'*. The elderly and infirm had appeared out of curiosity. Crofters recalled that elderly members of the community mentioned this was *'like old times'* and were happy to see *'the whole township coming together'*. Discussions were started as to how to continue this collaboration, whether new resources should be considered, e.g., upgrading the raceway, maybe via a collective initiative. During the online workshop there was also a discussion as to whether the momentum generated by the sheep scab work could be used to propel the crofters into managing other diseases collaboratively. The collective dipping has meant that some Townships with active common grazing committees will now refuse entry to common grazings for those animals not recently dipped or tested. Concern was mentioned that a few crofters were still relying on injectables for sheep scab treatment. However, as these crofters were not engaging in the collective action it had to be taken on trust that this had or would be undertaken. One crofter mentioned they would be reluctant to dip in future and felt they had not been given sufficient warning that dipping sheep exhibiting health issues would be unwise. They were re-assured that this would be addressed in the future and that alternatives would always be made available, i.e., injectable ML or blood testing. Blood testing in this case was used to ensure that animals were only treated when required. The use of blood testing is an important tool in cases where a farmer is reluctant to treat with an OP dip and also when an ML is used to ensure efficacy of treatment.

Concern that treatments would become compulsory was voiced. It was identified as a problem for those wanting to reduce treatments and practice regenerative farming, where treating only when

testing had identified a problem. There was a discussion on how this approach, once disease prevalence had been reduced, would help mitigate resistance to treatments.

The crofters also discussed the timing of treatments to control roundworms, in a coordinated and collaborative way. Options included treating sheep before entry to common grazings, at gatherings or when sheep were brought to fanks. Crofters saw several advantages, including reduced anthelmintic use in the future. A few crofters with small numbers of sheep mentioned that buying small quantities of wormers can be a problem, as bottles contain far more doses than they need which is expensive and leads to product wastage. There is a possibility of collective anthelmintic purchasing during coordinated dosing regimens, making it cheaper to treat livestock for roundworms. Discussions were also had about if treatments always worked and if not why. This led to a discussion about drench checks, and how they could be undertaken.

Peer to peer knowledge exchange was identified as useful to help newcomers to sheep keeping. They suggested it would be helpful if experienced crofters could be encouraged to talk to newcomers, share practices and warn of potential issues. Newcomers to crofting and the islands noted that being part of the collective action had *'got them* (accepted) *into the community'* due to their willingness to be part of the collective action. The experience had *'broadened the people we can speak to and ask for advice in future'* they described the process as *'romantic but grim and real'* referring to the way they had hoped their crofting life would be about community actions, but they could appreciate the action was out of necessity to ensure the health and wellbeing of the flock.

Guidelines and advice on timing of testing and treatments was requested to help people to realise a collaborative plan (see decision support tool section) and encourage crofters to engage with timely, coordinated action. There was a feeling that treatments which are required through regulations, possibly linked to common grazings, might be more adhered to and accepted. Some common grazings have this requirement, although enforcement can be challenging in a minority of cases.

Diseases

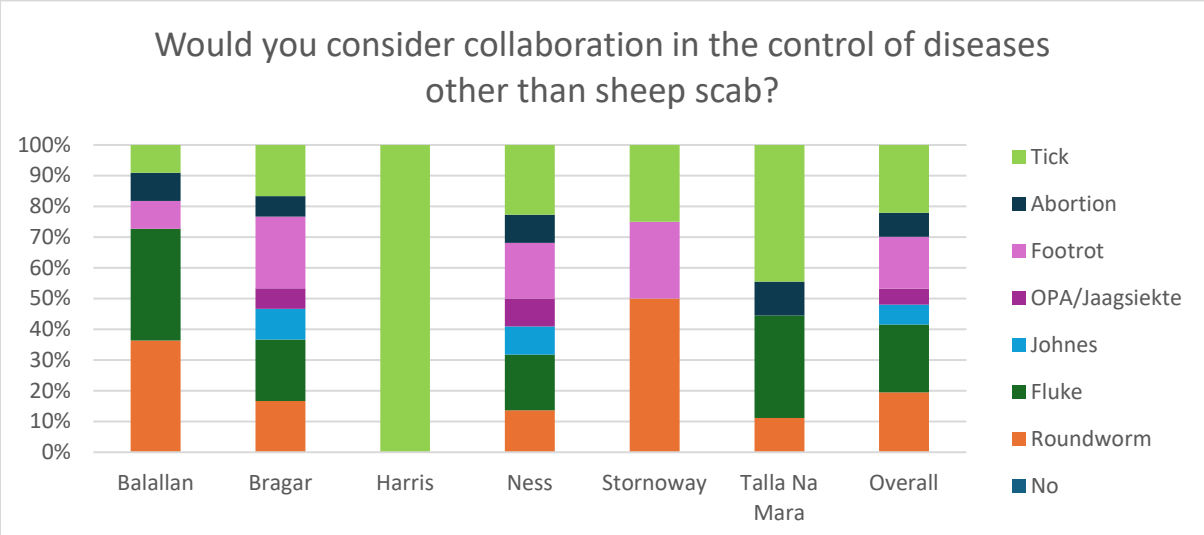

Figure 4. Multiple choice (clicker) question results from in-person workshops; "would you consider collaboration in the control of diseases other than sheep scab?"

Crofters were asked if, after the sheep scab intervention, they would consider tackling other diseases in a similar collaborative way (Figure 4). Overall, crofters indicated that they would consider coordinated control of several diseases. Liver fluke and tick-borne diseases were the conditions most commonly selected, followed by roundworms and footrot (selected by 17, 17, 15 and 13 attendees respectively). Diseases selected differed slightly between regions, perhaps reflecting observations of disease in these areas.

It became clear that most crofters had not heard of some of the diseases listed, particularly Jaagsiekte and Johnes. During the online workshop this was discussed in terms of both a lack of up-to-date crofter knowledge and education on diseases and best-practice management, as well as a lack of access to diagnostic services on L&H to make people aware of the extent to which these diseases may impact the islands. There were a small number of people that had heard of these diseases from working in other sectors. For example, some people had heard of Johnes' disease in cattle but not in sheep. The online group were also more aware of the diseases listed than most of the participants in the in-person workshops (e.g., OPA). There was some interest in these diseases and information was requested as to the symptoms, potential impact on livestock production and methods of treatment. Where possible, information leaflets were offered and website links to additional resources were shared.

Liver fluke was indicated as a problem. People were aware if they were in a fluke area, although they had not considered joint action with other common grazing users. A crofter mentioned having contact with the vet and receiving treatment advice for fluke control in the past. Crofters were interested in more fluke control and treatment advice going forward. A new initiative has started to assess the degree of concern with liver fluke amongst crofters, and Moredun scientists will be visiting L&H in 2024 to advise on best practice treatment.

Crofters in the majority of workshops indicated that they would consider a coordinated approach to testing and treatment for roundworms. Very little testing is carried out currently and crofters don't know what treatments their neighbours are administering. This could have implications for roundworm refugia on common grazing land, particularly given reports of increased sheep mixing due to lower animal numbers on the island reducing "hefting" (natural separation of flocks). Further research is required to understand the epidemiology of roundworms within common grazing systems to inform tailored recommendations for community-led roundworm control on the islands.

Footrot was a frequently encountered problem; many crofters had had problems with it, although joint control and treatment measures had not been previously considered. Ticks were a problem and were discussed at length. Tick numbers are largely considered to be out of control. Some collaborative action is already taking place in conjunction with sheep scab control, where dipping prevents tick infestation for three weeks. Not grazing some areas is thought to be helpful. Controlling deer numbers was thought to be the best action for tick control. Ticks were discussed as a problem for lambs and older sheep, and as a nuisance for people handling them. Tick-borne human disease was only mentioned as a concern by a few of the crofters.

Island control

In general, crofters were in favour of exploring island-wide collaboration to control diseases in the future. They expressed an interest in how this might be addressed, and a demonstration of the

Shetland livestock control virtual tour was given and the link shared. A visit is planned for a small group of key stakeholders on the islands to visit Shetland to see the process in place to control livestock disease of imported animals and meet key people involved in its implementation. This visit will help crofters on L&H identify what might be practical to implement on L&H.

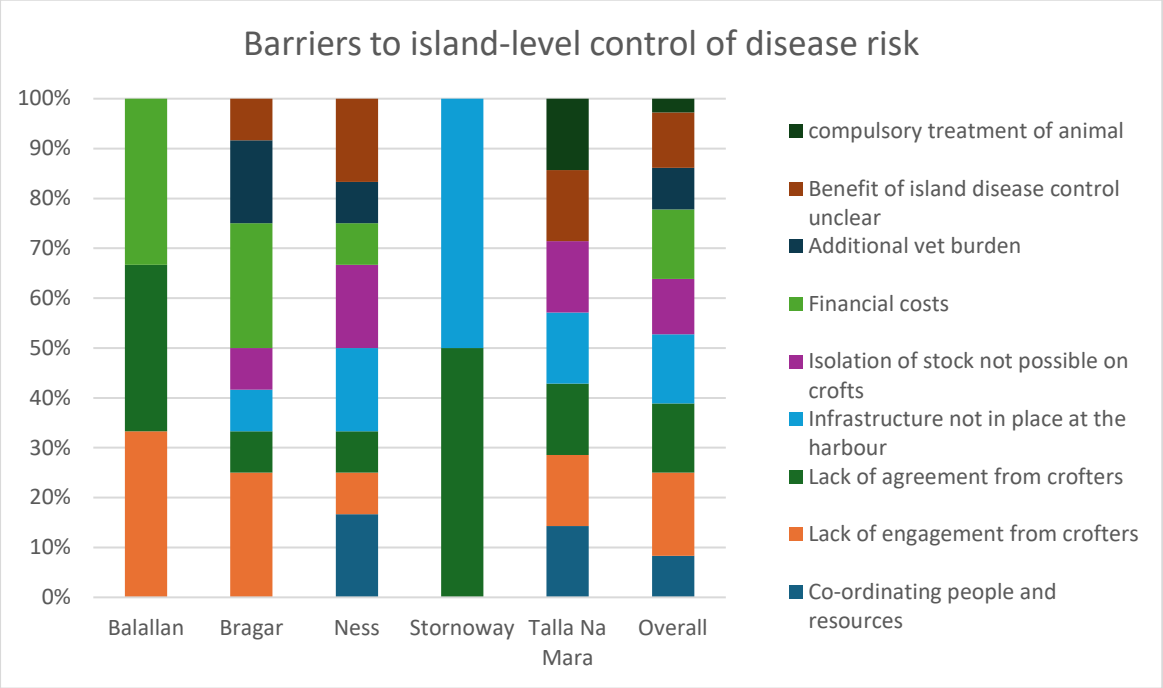

Figure 5. Multiple choice audience participation question results from in-person workshops; “in terms of island collaboration to control disease risk, do you see any barriers?”

Participants identified several potential barriers to the implementation of island-level disease control (Figure 5). The most commonly selected were lack of engagement and agreement by crofters, the infrastructure required and financial cost of implementing such a scheme (selected by 41%, 39%, 39% and 39% of participants respectively).

Participants in the online workshop suggested that lack of engagement by some crofters could, in part, reflect a lack of education as to the presence and severity of certain diseases on the islands. Some older crofters are less active with their crofts, keeping small numbers of sheep, and do not have the ability to comply with active control measures. These crofters may not be bringing sheep onto their crofts, but their animals would still be a risk to others, particularly on common grazing. Untreated sheep could act a reservoir of disease (e.g., sheep scab) and could re-infect treated sheep. For roundworms, untreated animals could provide a source of fully susceptible parasites, which would potentially protect treated animals by slowing the development of anthelmintic resistance. In addition, some of the townships have crofters that resist change and would not agree with compulsory measures. This might be managed via a change in bye laws, similar to those used in Shetland. The possibility of implementing change in island policies was discussed.

The number of ports on the island was identified as a problem, unless imports of livestock could be restricted to one harbour where new infrastructure could be provided. The financial burden of new infrastructure was a major concern that would require finding suitable funding. The costs for individual

crofters or townships to pay for vet services (e.g., sampling, analysing and treating livestock at the point of entry) was discussed and may require changes in policy. This may involve having a single port of entry designated for the import of animals or ensuring that animals brought on to L&H are inspected or transferred to a dedicated port prior to release to their individual holdings.

Coordinating people and resources was seen as a major stumbling block to this initiative. The sheep scab intervention has required a dedicated person to handle the logistics to ensure smooth operating of the dipper and motivating sheep owners to access the dipping facilities. In addition, sheep scab control champions in the townships have encouraged crofters to cooperate and become involved in whole community control of sheep scab disease to help protect all the sheep in the community flocks. Similar initiatives would need to be implemented to introduce island-level biosecurity practices and would need buy-in from the livestock market, port authorities and ferry operators.

Additional vet roles for an already overburdened vet practice was a concern. Support would be needed to cover for these additional roles, including trained staff and access to external diagnostic services.

A significant number of sheep are overwintered on the mainland and returned to the island in Spring. Enacting biosecurity in this situation was raised as a barrier to the implementation of island-level control. High costs associated with livestock import and health checks might make this practice untenable. A robust discussion on whether this management practice would be sustainable is required. Alternatively, a way to enable the practice to continue would need to be found, for example the testing and/or treatment of animals on their return in the Spring. This is dependent on sheep keepers willingness to pay the associated costs.

The benefits of having island-level disease control was discussed. A participant in the online workshop suggested that the crofters should be using to their advantage the region's status as an island, and that if Shetland were able to put in place effective biosecurity measures, they should be able to do the same. A potential increased intra-island demand for replacement ewes bred on L&H was seen as good for the island economy and beneficial for the health of island flocks. The ability to market island sheep as disease free was seen a positive move for L&H. It was hoped this would add a premium to sheep purchased from L&H and would help develop a respected and valuable brand.

Decision support tools

Crofting has traditionally followed seasonal practices; many management measures are routinely scheduled in the yearly calendar. The attitude 'it's always been done at this time' is hard to break. However, the timing and severity of infections are becoming increasingly variable, in part due to recent changes in weather patterns, more frequent extreme weather events, changes in treatments available (resistance issues, drugs being withdrawn from the market and new drugs being developed) and parasite adaptation. This unpredictability requires more flexible management strategies to ensure animal disease is controlled effectively and sustainably. To help implement new management strategies, many livestock keepers are using decision support tools (DSTs) to inform the changes. These tools are being developed by research institutes and industry specialists. To help understand to what degree DSTs are being utilised by the crofting communities, crofters were asked to select which tools they used. Engagement with DSTs was low; of the 35 participants surveyed, five had previously

used “FEC Check” (14%), three used the SCOPS *Nematodirus* forecasting map (9%) and three used the NADIS parasite watch (9%). Details for each decision tool were discussed.

- ***Nematodirus* forecast SCOPS**: a few answered that they had previously heard of and/or seen the SCOPS *Nematodirus* forecasting map but three were aware of and used it. Participants asked for information on SCOPS and indicated they would *‘have a look’* in case they could make use of it (the link was shared). Participants were concerned about the reliability, and therefore usefulness, of forecasts in the face of increasing climate variability.
- **NADIS** Parasite Watch: There was interest in a digital tool that forecasts fluke risk, but no one wanted to pay for this. A few people mentioned they doubted its accuracy to predict fluke risk to the scale they would require, with a participant in the online workshop noting that they felt L&H’s unique climate could make national forecasts less trustworthy. An accurate forecasting tool would be useful, but it was felt this would be difficult at an island level.
- **FEC Check (Moredun)**: Crofters were interested in the FEC Check digital tool to improve interpretation of faecal egg count (FEC) results. There was no faecal egg counting service provided on L&H and postal services took too long to return results. FEC Check also includes information on at-home “DIY” faecal egg counting which could be of use to the crofters. Two automated instruments (FECPAK) enabling crofters to undertake their own flock-level FECs, were made available for use. The FECPAK devices will be assessed for frequency of use, suitability (i.e., would an alternative service better suit the crofters’ requirements) and cost of an unfunded device.
- **Tick risk maps**: Crofters did not express an interest in this sort of DST either as a passive map or as an interactive tool. The feeling was the level of ticks were high and they were aware of this risk. No support tool would help in deciding treatment or management strategy.
- **Sheep scab diagnostics**: they were aware of the blood sampling and diagnostic tool being used to determine if sub-clinical sheep scab was present. They however felt this was a tool being used at a higher level (requiring the vet to take blood samples) to determine presence or absence of the sheep scab mites and to advise on treatment.
- **Other**: Several crofters mentioned, during more than one of the workshops, that an interactive calendar to inform them of high-risk disease periods would be useful. They felt the ability for the calendar to generate notifications of both risk levels and potential treatments would be an important feature. A changing climate meant that treatments need to be flexible, targeted and able to respond to weather events (i.e., long periods of wet weather, unusual periods of warm weather). Due to regional variations the notifications would need to be region specific.

Uptake of recommended biosecurity and disease control measures

Crofters were asked to indicate which disease control measures they currently use, which they plan to implement in the near future, which they might consider implementing in the far future, and those which were not suitable for their farming system. The measures were divided into 1) physical properties, 2) education and training, 3) ‘knowledge on the crofts’ and 4) disease treatments. Participants were encouraged to provide feedback on the language used (e.g., suggesting that the word ‘wormer’ be used rather than the word ‘anthelmintic’) and whether they thought the measures were appropriate for L&H.

Most of the participants currently undertook many of the measures listed or were planning to start in the near future. Most participants stated that they currently undertook the following measures:

- Secure fencing/boundaries around fields
- A separate field, housing or quarantine area with secure fencing for newly introduced sheep
- Access to, and use of, handling facilities (mobile or permanent structures)
- Anthelminthics are stored correctly and the user has read the product instructions
- Access to a specialist and/or veterinary advice
- Simple record keeping (manual or electronic)
- Have, and implement, a basic flock health plan designed for their holding
- Anthelmintic treatment of incoming/new stock

A number of the practices were perceived as not appropriate for their farming contexts. Crofts were described as small (in terms of physical area and numbers of sheep kept), with few options to change the current ways of working. Thus, measures that required additional and/or more privately owned infrastructure and equipment were considered difficult to put in place. One crofter in the online workshop stated that they would never be able to recoup the costs of investing in newer technologies. Other measures, such as dedicated areas for quarantining new and returning animals, and ensuring staff are up to date with training were seen as problematic as there are rarely additional 'staff', physical space on crofts is limited, and animals, such as tups are often needed to work as soon as they arrive on a croft, providing scant opportunity for quarantine, treatment, or testing.

The potential cost of practices (e.g., ensuring secure fencing, and enacting island level disease control via barrier controls at ports), and a lack of awareness or understanding of the benefits of certain practices (e.g., turning treated animals out onto dirty pasture) were two important barriers to the current and future uptake of many of the disease control measures discussed with the crofters.

The definition of closed flock

Of the crofters who participated in the in-person workshops, a total of 19 answered the question about keeping a closed flock. Seven reported that they currently kept a closed flock, three that they could move towards keeping a closed flock in the near future, and nine that could do so in the far future. However, there was confusion amongst the participants about what the concept involved and how it could be applied on the islands, with many participants asking what it actually meant. Within industry and research, the concept of a 'closed flock' is variously understood and implemented and how long a flock must be closed for it to be described as such is not standardised in practice. The concept may be understood in terms of control of introduced animals. A closed flock typically refers to a farm where no new animals are brought in, i.e., by breeding replacement ewes, and the use of artificial insemination (AI) technologies.

Some workshop participants stated that they kept a closed flock but when asked to describe this, they considered it to refer to only the female animals. Discussion highlighted that AI was not commonly used on L&H and that tups are often shared between crofts. Participants highlighted that shared or rented animals are moved frequently, not providing sufficient time for quarantine before introducing them to the flock, increasing the risk of disease spread. Similarly, tups purchased late in the year (described as "*emergency tups*") are required immediately, with a participant in the online workshop stating that they often "*…did not have the luxury of time…*". This further highlights the need for bespoke, best-fit advice tailored to crofting systems.

Hypothetically, keepers of closed flocks may also limit trade and non-trade related movements for biosecurity reasons. This can be achieved by not showing sheep at agricultural shows, and/or preventing nose-to-nose contact with neighbouring flocks, e.g., via double fencing. Maintaining a closed flock may also require consideration of other routes of disease spread, e.g., limiting the use of

shared equipment and infrastructure, and ensuring (human) visitors disinfect their clothes and shoes before interacting with the flock. Applying these measures in practice on the islands may be challenging.

Some participants could see the potential benefits of breeding their own replacements as a way to improve the quality of their own and the island's stock. One participant questioned what happened to a flock's closed status when a crofter decides to change the breed kept. At what point can the flock be referred to as closed again? This highlights the general confusion about the use of the term.

Some participants noted that crofts rarely have enough land to feed the animals kept, necessitating use of common grazings. When this occurs, it was thought that a flock could not be described as closed as there may be physical contact between different flocks, with one participant stating, "*can't be closed if [you] use common grazing*". Crofters also often share equipment and other infrastructure (e.g., trailers, fanks, contract shearers and scanners) which is an acknowledged disease risk. Thus, these participants did not think the concept of a closed flock was compatible with crofting farming practices. In addition, many fences on the island were described as in a poor state of repair, allowing animals to move between different holdings, which was seen as a potential barrier to the development of closed flocks and a risk for disease transmission.

Finally, a participant asked if the scale at which the concept of a closed flock is considered could be context specific. They suggested that instead of trying to develop many closed flocks on many different holdings, L&H could have 'township flocks' or an 'island flock' ("*What is the scale of a closed flock? Could it be an island flock?*"). However, this is currently hampered by a lack of management and coordination at the community and island level around biosecurity. Only three participants stated that they have a basic flock health plan designed for their township. Only one participant said they took part in community level disease control, and one took part in island level disease control.

Fencing: management of disease and/or stock movements

The majority of the crofters stated that they already had secure fencing/boundaries in place around their fields. Nevertheless, fences on the islands were described as generally in a poor state of repair. This means that enacting biosecurity may be challenging and allows animals to cross the boundaries between different fields and holdings, facilitating disease spread.

A participant stated that fences on the island were often designed to be inward, rather than outward looking, intended for stock control rather than enacting biosecurity. They felt that this was an important distinction to make because the types of fencing/boundaries required to achieve these two goals would likely be different. Advice on biosecurity for livestock farmers often promotes double fencing (e.g., advice from the AHDB[1]). However, this presents problems for crofters. Firstly, most fencing on L&H is single plain or barbed wire and there is little to no double fencing in place. This means that nose-to-nose contact between animals in different fields and from different holdings may be possible. Secondly, the nature of the field system in place (favouring fields made up of long, thin tracks of land) means that double fencing, if financially possible, is likely to be spatially impractical, as noted by a participant in the online workshop. Thirdly, croft abandonment means that not all fences are regularly repaired, with one participant stating, "*good fences show that the croft is probably occupied, poor fences suggest that the croft is abandoned*". This may mean that animals can range across abandoned crofts, over which a neighbouring crofter has little control. A participant in the

[1] "Where both you and your neighbour are grazing livestock, you should run double fencing, three metres apart, through areas where livestock grazing adjoins." (https://ahdb.org.uk/biosecurity-boundary-risks-and-fencing, AHDB, 2024)

online workshop stated that crofters that do not keep animals often do not think it is their responsibility to maintain stock-proof fences on their holdings. Thus, achieving disease management via the separation of stock is challenging. This also makes the effective quarantining of animals brought on to holdings difficult.

Participants noted that when crofters seek to improve boundaries on their crofts, they prioritise certain areas over others in order to maximise the benefits of their limited resources (e.g., in terms of the time and money needed). Areas of high priority included fields used for lambing and tupping, where stock control is important ("*Tupping and lambing areas are areas to focus fence work on*"). The upkeep of fences and boundaries around other fields which may have less important roles, or be used less often, are perceived to be of lower priority, with one participant stating that "*…[the] used area [of the croft] is done, but not the entire croft*". Quarantine areas to isolate new and returning stock were not mentioned by crofters as a fencing priority, perhaps highlighting an opportunity to convey the importance of this practice in the future. Nevertheless, a participant in the online workshop noted that crofters are often unwilling to invest in improving fences due to the lack of security around land tenure. There is also the potential for neighbours not to respect the newly installed fences, leading to damage and disrepair.

It was mentioned that it was expensive for crofters on L&H to repair and replace fences and that there was a lack of fencing contractors willing to take on the work of improving the islands' boundaries (*"There is a lack of fencing contractors, the big companies are too expensive.*"). Finally, a participant in one of the workshops stated, "*how does secure fencing work in relation to communal grazing?*" They questioned the importance of secure fencing for disease management on individual holdings within a crofting system that makes use of areas communal grazing.

Messaging

A robust discussion on messaging was initiated at each of the workshops. The content for the messages was of paramount importance to the crofters.

- Simple messages
- Targeted advice
- Easy to put into practice measures, specifically designed for their unique context
- Dosing calendar
- Wormer poster showing details of available wormers, target species, size available (in leaflet size to be taken home and be studied at leisure)
- Information on research to back up advice

The most appropriate format to provide messaging was discussed and the crofters' suggested the best formats to reach large audiences on the islands.

- Newsletters (sent to Clerk of common grazing committee, to allow distribution and to be discussed at meetings)
- Podcasts
- Videos
- Webinars
- Infographics/animations
- Leaflets

- Hands on practical events

The ways the information could be distributed was also key to discussions.

- Email alerts/notifications
- Social media (WhatsApp group, Facebook)
- Local radio
- Local newspapers
- Local TV
- Mart advertising (back of mart catalogues, would need to be seasonal)
- YouTube (a specific channel), linked with sheep Game and Hoof GP
- Agricultural shows
- Farm Advisory Service

Shetland Disease Control Virtual Tour

The virtual tour (VT) used interactive footage to show the procedure used in Shetland to keep the islands livestock disease free. All animals are inspected, and blood samples are taken at the point of entry. Prior to livestock being dispersed to holdings, animals are treated with injectables against sheep scab and provided with wormer treatment. All sheep are transported by their owners to the island dipper (hosted and maintained at the port facility) to be dipped. Livestock are isolated on the keepers' holdings whilst awaiting test results. The VT provides an interactive tour of the procedure allowing viewers to see important processes at their own speed, creating a bespoke viewing experience each time they visit the website. A demonstration of the VT was shown to showcase the content and the functionality of the tool.

The VT was well received, and it generated good discussion. Participants asked for the link to allow them to view the VT at their leisure. This was shared during the workshop and again in a follow-up email. A visit is planned to take some islanders to visit Shetland, allowing them to see first-hand the procedure. Barriers and challenges of implementing island disease control measures will be discussed during this visit.

Attitudes to roundworm control

Roundworms are ubiquitous throughout the UK and were acknowledged as an ongoing problem for sheep producers on L&H. As highlighted throughout the results, roundworm control was typically based on anthelmintic (wormer) treatment, administered on pre-determined dates with very few participants conducing faecal egg counts to inform the requirement for treatment, optimal timings or efficacy testing. Knowledge was lacking on roundworm biology, epidemiology and control options.

A talk on the basics of roundworm infections was provided which included the parasite lifecycle, clinical signs of infection, diagnostic testing and control options. Participants were unclear on the different anthelmintic groups, which products belonged to each and the current status of resistance to these chemicals in the UK.

Faecal egg count testing was not previously available on L&H without posting samples to the mainland. The delay in results was highlighted as a key deterrent, as well as the logistics of collecting samples from animals on common grazing. This prompted discussion of collecting fresh samples from the

ground to perform pooled testing. This type of approach would provide an opportunity to understand the parasite challenge to animals on the common grazings and could inform township-level coordinated roundworm control.

Discussion

The workshops have highlighted key knowledge gaps for the crofters on Lewis and Harris surrounding biosecurity and disease control however, they have also demonstrated a desire for information and tailored recommendations.

Current best practice recommendations have been designed for large-scale, mainland commercial farms and don't necessarily translate to crofting systems. To ensure crofters attempt to implement good practice, the industry must understand the limitations of these rural and island systems, develop tailored advice and communicate it clearly.

It was evident from the workshop findings that one of the barriers to uptake of recommendations was education, particularly a lack of awareness of different sheep diseases and a lack of understanding of the benefit/rationale behind some practices. During the workshops, we provided information on roundworms and sheep scab, including the clinical signs, biology and epidemiology of the parasites, available diagnostic tests and treatment options. Additional resources were signposted during the sessions to allow crofters to find information on other diseases if desired. It is important that stakeholders understand the basic biology of parasites and what drives the development of drug resistance, as this will add clarity to the rationale behind recommended on-farm practices and encourage uptake.

The structure of crofting systems and common grazing provides many hurdles to the implementation of effective biosecurity, but it also provides the opportunity for coordinated, community-level disease control. The island-wide sheep scab control program has been a great success to date and has highlighted the island's enthusiasm for community-driven projects. The positive feedback, particularly around the sense of community support, provides an opportunity for future collaborations. Roundworm control within common grazing systems may be complex, however there could be opportunities to develop coordinated control programs for crofts using each common grazing. Such programs could be designed to maximise roundworm refugia on grazing land with additional benefits such as reduced treatment costs by buying larger quantities of anthelmintics between townships and shared labour for gathering and sheep handling.

Beyond coordination of control measures at the township level, workshop participants were keen on the idea of island-level biosecurity, similar to the program developed on Shetland. By capitalising on the unique benefits of their island status, Lewis and Harris could implement biosecurity restrictions on animals imported from the mainland, reducing the risk of introducing novel disease threats to the island flock. With continued efforts to eradicate sheep scab on the island, sheep producers could potentially benefit from certified scab free flocks in the future, perhaps affording a premium on exported animals.

An important finding from the workshops was around the communication of messages, particularly the language used in recommendations. There was confusion over technical jargon (e.g. 'anthelmintic'

and 'efficacy') during discussions about which practices participants were currently implementing. This follows previous findings from the first set of workshops which highlighted a lack of understanding around the term 'biosecurity'. This study has highlighted a range of technical language which is not universally understood and which needs to be changed or clarified within recommendations. Finally, when asked about messaging, participants mentioned a range of media and platforms, emphasising that there is no one-size-fits-all approach and that information needs to be communicated through a range of methods to reach different aspects of the intended audience.

Next Steps

- Interviews with crofters
- Shetland small group visit
- Sheep scab testing
- New dipping
- FECPAK instruments and training to be made available.

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[3] https://www.agrilink2020.eu/

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