University of the Highlands and Islands Orkney College

AGRONOMY INSTITUTE

AGRONOMY INSTITUTE

- For Northern Temperate Crop Research -

ANNUAL REPORT

(April 2018 to March 2019)

Sowing Bere on Orkney at Inganess Farm In April 2018

Agronomy Institute,
Orkney College UHI,
Kirkwall,
Orkney,
KW15 1LX.
www.agronomy.uhi.ac.uk

University of the Highlands and Islands Oilthigh na Gàidhealtachd agus nan Eilean

Contents

1 Introduction

The Agronomy Institute (AI) is a plant-based research centre at Orkney College UHI which is an academic partner in the University of the Highlands and Islands (UHI). This report covers the year from April 2018 to March 2019. During this period, AI research activities were concentrated on a Scottish Government funded heritage barley project in collaboration with the James Hutton Institute (JHI) and a Northern Cereals project with researchers from north European countries funded by the Northern Periphery and Arctic Programme (NPAP). Other collaborations also continued with researchers at the Universities of Copenhagen and Sheffield on Bere barley and with Forestry Commission Scotland on short rotation forestry. A new collaboration, aimed at tackling constraints on the development of local food and beverage value chains, started with researchers in Finland, Norway and Greenland through an NPAP preparatory project. On the commercial side, the AI continued to manage a Bere barley supply chain to provide grain for malting to Bruichladdich Distillery, Swannay Brewery and other end users, and collaboration continued with Raasay and Borders (R&B) Distillers, to investigate the feasibility of growing barley on Raasay for use by their new distillery on the island. A new project started in 2019 with Norse Pilgrim Ltd to help the company grow tea on the island of Shapinsay.

2 Background

The AI was opened at Orkney College UHI in June 2002. Its mission statement is “to establish an internationally recognised centre for the research, development and promotion of northern temperate plants and their products which contributes significantly to the sustainable economic, social and environmental well-being of the Highlands and Islands of Scotland”. This is being achieved by a research and development programme which is focused on:

- Identifying and screening crops and plants with potential for commercialisation in the Highlands and Islands, taking into account their potential impact on the environment and biodiversity.
- Collaborating with growers and end-users to develop *Best Practices* and supply chains for these crops.
- Stimulating the market for crops grown in the Highlands and Islands by collaborating with end-users to develop new products.

- Developing collaborations with other research organisations to bring economic and research benefits to the Highlands and Islands.

The AI's development aims are delivered through a combination of field trials, research projects and commercial linkages which are outlined below.

3 Links With Other Organisations And Profile Raising Activities

As an emerging research centre in the north of Scotland, the development of collaborative links with other organisations is very important and over this reporting period the AI actively engaged with individuals in the following organisations:

Knowledge exchange visit by Orkney Bere stakeholders to Bruichladdich Distillery in January 2019 to see the distillation of spirit made from the 2018 Orkney crop.

- *Research Organisations:* Agricultural Centre (Faroe Islands); Agricultural University of Iceland; Forestry and Agrifoods Agency (Government of Newfoundland & Labrador, Canada); Forestry Commission Scotland; LUKE (Natural Resources Institute Finland); MATIS (Icelandic Food and Biotech R&D); NIAB (National Institute of Agricultural Botany); NIBIO (Norwegian Institute of Bioeconomy Research); The James Hutton Institute (Invergowrie, Dundee); and the Universities of Copenhagen, Manchester and Sheffield.

- *Commercial Companies:* Bairds Malt; Bruichladdich Distillery; Crisp Malt; Lantmännen SW Seed AB; Norse Pilgrim Ltd., Orkney Distilling Ltd; Orkney Craft Vinegar; Orkney Wine Company; R&B Distillers Ltd; Swannay Brewery; The Rookery Craft Mead.

- *Growers, Grower and End-User Groups and Trusts:* Agriculture and Horticulture Development Board; Balfour Castle Estate; Birsay Heritage Trust; Orkney Bere supply chain; Orkney Food and Drink.

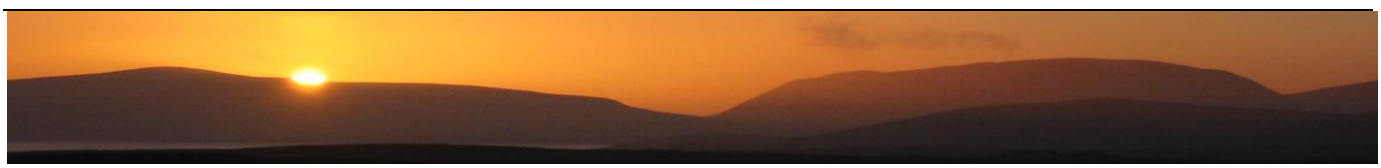
The AI contributed to several knowledge exchange events. These included: an open event on Raasay with R&B Distillers in August 2018 and a presentation on Bere in January 2019 to farmers in Birsay. In collaboration with Bruichladdich Distillery, the AI also organised a visit for Orkney Bere stakeholders to the Distillery in January 2019 which was timed to coincide with the distillation of the 2018 Orkney crop of Bere at the distillery.

Open event in August 2018 at the barley variety trial run by the Institute for R&B Distillers.

4 Impact Of The Agronomy Institute

The Institute has continued to make an impact at several levels:

- Growers and stakeholder groups have benefited from the new markets for crops and supply chains which the AI has developed as well as its knowledge exchange activities, particularly with cereals. In 2018, for the twelfth



successive year, Orkney growers planted about 30 ha of Bere for specialist whisky and beer markets which the AI has helped to develop. On the Inner Hebridean island of Raasay, the Institute helped a farmer for the second year to successfully produce a crop of barley which will be used for distilling by the new Raasay Distillery. Small scale production of fruit (by Orkney Wine Company) for wines and liqueurs, and botanicals (by Orkney Distilling Ltd) for gin, has been made possible through help provided to these companies to establish their own crop production areas over the past three years.

Adding malt, made from local barley, to the mash-tun at Raasay Distillery in August 2018. The barley came from the 2017 crop trials run by the AI and was the first in living memory to be harvested on the island.

- Commercial companies have also benefited as crops have been made available for the development of new products. Thus, in 2012 and 2014, Isle of Arran Distillers produced two limited edition Bere whiskies, since 2014 Bruichladdich Distillery has released the first five of a series of Bere whiskies, and Valhalla Brewery in Shetland and Swannay Brewery in Orkney have both produced beers using Bere malt supplied by the AI. Since 2012, collaboration between the AI and the Orkney Wine Company has resulted in the release of three new wines and a liqueur, and both the Orkney Wine Company and Swannay Brewery have developed successful cask-matured products using casks supplied by the Institute. In 2016, Orkney Distilling Ltd released its first product, *Kirkjuvagr* gin, which contains Orkney botanicals supplied by the Institute and in 2017 Orkney Craft Vinegar was helped to produce a cask-matured Bere malt vinegar. On the Inner Hebridean island of Raasay, barley produced in trials run by the AI for R&B Distillers on the island was malted and distilled at Raasay Distillery in 2018.

- As a research centre within UHI, it is particularly appropriate that the benefits of AI activities are spread over the Highlands and Islands. In addition to the Institute's strong Orkney links, recent collaborations with commercial organisations in Shetland (Shetland Livestock Marketing Group and Valhalla Brewery), Islay (Bruichladdich Distillery), Arran (Isle of Arran Distillers) and Raasay (R&B Distillers Ltd) demonstrate that the Institute's activities impact on diverse parts of the region. Collaborations between the AI and other research centres (e.g. the James Hutton Institute, the Rowett Institute and Forestry Commission Scotland) help these organisations deliver research projects benefiting remoter parts of the Highlands and Islands.

Botanicals garden established for Orkney Distilling Ltd by the Agronomy Institute. Plants in the foreground and background are aronia and angelica, respectively.

- With an aspiration for both national and international recognition, it is crucial, not only that the AI has international links (see Section 3) and collaborations (e.g. through the Northern Periphery and Arctic Programme), but also that its research outputs are of a high quality and contribute significantly to UHI. In recent years, AI staff have made important contributions to scientific publications on cereals, willow and natural products and the Institute was part of UHI's submission to the 2014 Research Excellence Framework (REF).

5 Plant Research Themes

As a result of reviews of potential markets for local crops in the Highlands and Islands, the AI has identified several research themes on which it is concentrating. Within each theme, a number of potential crops have been tested and subsequent research has focused on those crops and themes for which funding or commercial opportunities have been available. The main research themes are reviewed below:

5.1 Early-Maturing Cereal Varieties

Barley variety trial on Raasay testing four early maturing varieties. The earliest variety (far left fully senesced strip) was *Iskria* from Iceland.

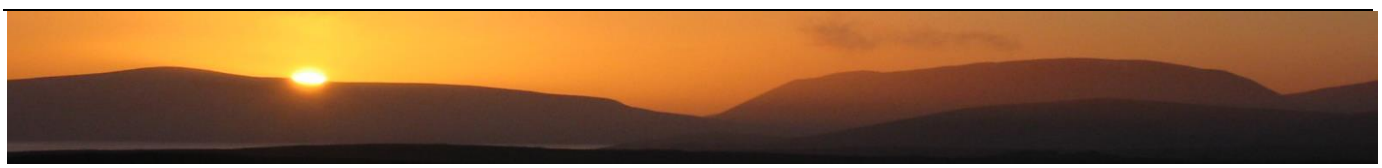
Under this theme, the Institute is investigating both modern and heritage cereal varieties which are early-maturing and therefore suited to growing in the Highlands and Islands' short, cool growing season. They are mainly being considered for food and drink products and include varieties of barley, wheat and oats. Early-maturing varieties from Northern Europe are thought to be very suitable for the north of Scotland, and Icelandic, Finnish, Swedish and Norwegian varieties have been grown successfully in Orkney and some have been tested on Raasay. AI research and commercialisation activities have focused particularly on the ancient Scottish barley landrace, Bere, which is very early-maturing and has a long association with Orkney. A diverse range of UK and Scandinavian heritage barley types were grown at Orkney College from 2016 to 2018 as part of a collaborative project with the James Hutton Institute funded by the Scottish Government.

5.2 Woody Biomass Crops

Initial AI research into biomass crops focused on willow (*Salix* spp) grown as short rotation coppice (SRC) which was investigated as a possible source of local renewable heating fuel to help reduce dependence on fossil fuels. This resulted in the establishment of several trials between 2002 and 2007.

Trees of common alder in December 2018 at the Muddisdale short rotation forestry trial. This is one of the best performing species in the trial and by the end of its sixth growing season had reached an average height of 3.2 m.

Since 2011, the AI has been collaborating with Forestry Commission Scotland and Orkney stakeholders to investigate the potential for short rotation forestry (SRF) in Orkney. For SRF, trees are planted at a closer spacing (c. 2,000-3,000 trees/ha) than for normal forestry. Fast growing species are used, with the objective of harvesting them at about 15-20 years. Several of these species can be coppiced and should therefore regenerate after harvesting. SRF systems are considered particularly suitable for the establishment of small areas of woodland on farms, where the wood could have a number of end-uses, including firewood. A major advantage of SRF for small-scale growers in remote areas is that harvesting and processing into a fuel (e.g. split logs) does not need costly, specialised machinery. In contrast, willow SRC does not usually reach a diameter suitable for burning as logs, is normally processed into wood chips and requires access to an expensive, dedicated harvester and, depending on harvesting method, a wood chipper.



5.3 Plants For Natural Products

Plants in this theme could have a wide range of end-uses, but several of those investigated in recent projects have been grown for pharmaceutical and cosmetic products, or flavourings. These include sweet gale (*Myrica gale*), the source of a high-value cosmetic oil and *Narcissus* cultivars as a source of galanthamine for treating Alzheimer's disease. Others, like angelica (*Angelica archangelica*), marshmallow (*Althaea officinalis*) and meadowsweet (*Filipendula ulmaria*) have been grown as flavourings.

Prolific flowering of aronia in June 2018 resulted in an excellent crop of fruit in September, with production exceeding 4 kg per bush.

Several northern berry crops have the potential for supplying high-value extracts for the nutraceuticals / health food supplements sector as well as products for the food and drink industry. Species being grown by the AI include cranberry (*Vaccinium macrocarpon*), sea buckthorn (*Hippophae rhamnoides*), aronia (*Aronia melanocarpa*), Saskatoon (*Amelanchier alnifolia*), low-bush blueberries (*Vaccinium angustifolium*), salal (*Gaultheria shallon*) and elder (*Sambucus nigra*).

6 Projects And Commercial Activities

Income from research projects and commercial activities are vital for ensuring the financial sustainability of the AI. In 2018/19 the AI was involved in the projects and commercial activities outlined in the following sections:

Trial of heritage and modern barley accessions at Orkney College in late July 2018. Most of the plots which are still green are modern varieties while many of those which have lost their colour are early maturing accessions of Bere.

6.1 Cereals

Bere Barley Adaptation To Scottish Island Low Input Agriculture

This project started in 2016 and is funded through the Scottish Government's Rural and Environmental Science and Analytical Services (RESAS) Division. As part of a wider research programme supported by RESAS on Biodiversity and Ecosystem Function, the Institute is collaborating with researchers at the James Hutton Institute (JHI) to investigate genetic diversity and local adaptation in Scottish barley landraces. Through the project, the partners aim to help preserve and utilise novel genetic diversity which exists in landraces to improve the sustainability of the Scottish barley crop which is nationally important for the high value distilling and brewing industries and also for animal feed. Since many of the Bere accessions originate from the Northern or Western Isles, the Institute's northern maritime trial sites and research facilities are particularly appropriate and useful for the project.

The Orkney trial programme includes: 34 accessions of Bere (including 18 which have a Northern or Western Isles provenance); 7 accessions of other Scottish landraces; 15 accessions of Scandinavian landraces; 40 accessions of non-Scottish British landraces; and 16 modern varieties. In addition to producing seed for larger-scale trials, phenological traits, growth and production data are being collected on all accessions while tissue and grain samples are being used by JHI for mineral analyses and genotyping. In 2018, the research included a sandy nutrient-

deficient site at Burray where tolerance to manganese deficiency was investigated in the F2 population of crosses between Bere and a modern variety.

Barley growing in a trial on a sandy soil in Orkney during 2018. The top row is a modern variety and shows serious manganese deficiency. The Bere plants in the bottom row have a tolerance to soils deficient in trace elements and are progeny of seed originally collected from Unst in Shetland.

Northern Cereals – New Markets For A Changing Environment

This project ended in May 2018 and was funded by the Northern Periphery and Arctic Programme. Other partners in the project included Iceland (MATIS and Agricultural University of Iceland), northern Norway (NIBIO), the Faroes (Agricultural Centre) and Newfoundland and Labrador (Forestry and Agrifoods Agency). The project developed as a result of a mutual perception amongst the partners that cereal growing in their regions, although still very challenging, has been favoured in recent years by a number of factors, including new varieties, warmer growing conditions and increased interest in "local" production and sustainability. The aim of the project was to increase cereal production in the partner regions in order to promote greater self-reliance and to facilitate the development of new markets. It built on the collaboration and experience developed by the partners in an earlier NORA-funded cereal project.

Within the project, the AI led work packages on beverages and market analysis and co-ordinated a study by the partners into the effects of recent warming on temperatures during the barley growing season and the impact this has had on growing the crop across the North Atlantic Region. The Institute also produced several guidelines, case studies and reports for the project, provided help to a number of commercial companies and growers and participated in several knowledge exchange events.

Tackling constraints on local value food and beverage chains in northern regions

A preparatory project on the above theme was funded by the Northern Periphery and Arctic Programme to develop a follow-on main project proposal. Led by LUKE (Natural Resources Institute Finland), the preparatory project included three other Finnish partners, two from Norway and one from Greenland, as well as the Agronomy Institute. Following a project meeting in Oulu, the main project proposal was submitted in November 2018.

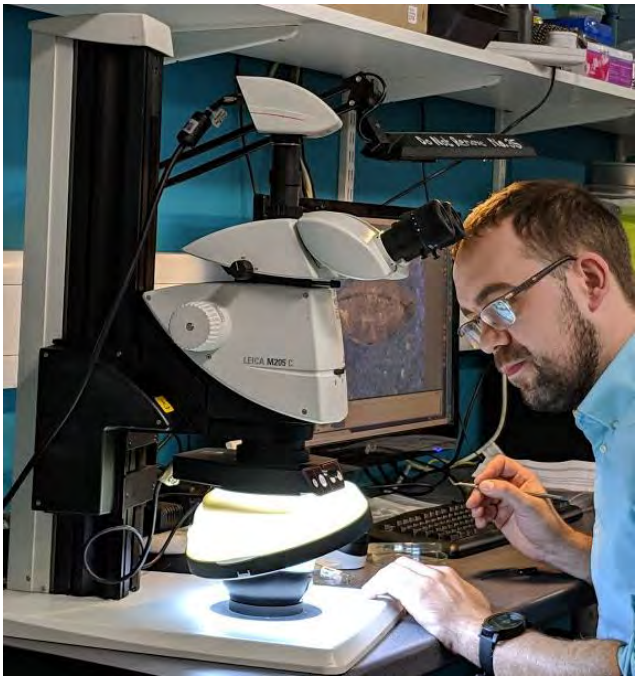
R&B Distillers (Isle of Raasay Distillery)

Raasay and Borders (R&B) Distillers opened a new distillery on the Hebridean island of Raasay, near Skye, in September 2017. The company is keen to source some of the barley used by the distillery locally but, since the crop has not been grown there for a long time, it approached the Institute to help it investigate the feasibility of doing this. One of the main challenges identified is very high rainfall around harvest time, and records suggest that conditions in August are likely to be more favourable than in September. On-farm variety trials in 2017 and 2018, therefore included early-maturing varieties from northern Europe and these were successfully harvested in both years. Grain from the 2017 crop was malted and distilled at Raasay Distillery in August 2018, and testing is continuing in 2019. This research has been supported by assistance from the James Hutton Institute.

Billy Scott harvesting barley from the variety trial on Raasay in September 2018.

Researching The Origins Of Bere

This is an initiative which is being pursued by the Agronomy Institute in collaboration with the Archaeology Institute at Orkney College and other archaeologists and biomolecular archaeologists at the Universities of Manchester and Sheffield and molecular geneticists at the James Hutton Institute. The collaboration is investigating whether geometric modern morphometric (GMM) analysis of grains and/or DNA extraction techniques can be used to investigate possible relationships between today's Bere and dated samples of 6-row hulled barley grains from selected archaeological sites in Scotland. It is hoped that this may provide information about the antiquity of Bere and perhaps indicate the route by which it was introduced to Scotland. Promising initial results from GMM indicate that the technique can be used to distinguish modern Bere grains from those of a number of other types of barley and, importantly, that the distinctive morphometric signature of Bere grains survives charring. This is crucial for GMM to be used on grains recovered from Scottish archaeological sites as most of these grains have been preserved through charring.



Michael Wallace (University of Sheffield) preparing grain samples from archaeological sites for morphometric analysis as part of on-going research into the origins of Bere.

Supply Chain For Bere

For the twelfth year, the AI ran a Bere supply chain with local growers and, over 50 t of Orkney-grown grain was supplied to Bruichladdich Distillery and Swannay Brewery. Bruichladdich uses Bere to produce high provenance *Bere Barley* whiskies which are released as separate vintages, while Swannay Brewery uses Bere in two recently developed beers, *Scapa Bere* and *Bygg*. Bere malt from the supply chain has also been used by Orkney Craft Vinegar to produce their Bere malt vinegar. The profile of this product received a major boost in February 2019 when it was enthusiastically endorsed by celebrity chef James Martin on his ITV Saturday Morning Show.

Bygg, a new beer made with malt from Orkney-grown Bere, released by Swannay Brewery in 2018.

6.2 Woody Biomass

Short Rotation Forestry (SRF) Project

Since 2011, the AI has been collaborating with Forestry Commission Scotland (FCS) in a project to investigate the potential of SRF in Orkney. As part of the project, two SRF trials were established in 2013, one at Muddisdale near Kirkwall and the other at Newfield on the island of Shapinsay. Both trials contain the same nine species (sycamore, *Acer pseudoplatanus*; Italian alder, *Alnus cordata*; common alder, *Alnus glutinosa*; downy birch, *Betula pubescens*; beech, *Fagus sylvatica*; aspen, *Populus tremula*; goat willow, *Salix caprea*; mountain ash, *Sorbus aucuparia*; whitebeam, *Sorbus intermedia*). Monitoring of the trials continued in 2018 in collaboration with FCS and results from the trials are being included with those from others established by the Commission in Scotland to provide a nation-wide data set and recommendations for growers (https://scotland.forestry.gov.uk/supporting/strategy-policy-guidance/climate-change/woodfuel-and-bio-energy/energy-forestry-exemplar-trials). Although survival at the end of the first year was very good at both sites, by the end of 2018 there had been many more tree deaths at the more exposed and wetter site at Newfield. In both trials, common alder, aspen and goat willow are the tallest species while sycamore, mountain ash and beech have made least growth.

6.3 Plants For Natural Products

Orkney Botanicals For Flavouring Gin

In 2016, Orkney Distilling Ltd (ODL), was established and the company started implementing plans for a new distillery and visitor centre at a prime site on the Kirkwall waterfront. In collaboration with Strathearn Distillery and with help from the Institute, the company developed its first product, *Kirkjuvagr* gin, later in the year. The gin includes a range of locally grown botanicals identified and grown for it by the Institute. In 2017, the AI helped ODL establish a botanicals garden which will allow it to produce its own locally grown botanicals. One of the key botanicals in the gin is angelica (*Angelica archangelica*) which was grown from seed originating from a naturalised stand of this plant in Westray. The occurrence of this stand is unusual but is thought to have existed for at least one hundred years and, in the past, was attributed to an introduction by Faroese fishermen. Building on links developed through the Northern Cereals project, collaboration has started with Icelandic researchers to compare Orkney angelica with that from other parts of the North Atlantic region.

Northern Fruits For Orkney Wine

Orkney Wine Company (OWC) produces a range of fruit wines and liqueurs using non-grape ingredients. Since 2012 the AI has been helping the company source unusual, locally grown ingredients to produce unique wines with a high content of local fruit. Several of the species have been in Institute research trials since 2004. The collaboration has been assisted by chemical analyses of the fruit species and wines, carried out by the James Hutton Institute. During 2015, the AI helped the company establish its own fruit garden so that it can expand production of wines made from local fruit. Commercial products which have resulted from this collaboration include the wines *Orkney White, Orkney Rosé* and *Viking Red*, and the liqueur *Kvasir.* These products contain fruits of cranberry, aronia, elder and salal and flowers of elder, supplied by the Institute.

The AI helped Orkney Craft Vinegar develop its Bere malt vinegar. This is a cask-matured speciality product aimed at a growing market for high-end culinary ingredients.

Growing Tea On Shapinsay

Although tea (*Camellia sinensis*) is more suited to being grown in warmer climates, there is increasing interest in growing it in Scotland for a high value market for high provenance teas with special flavours. While Scottish tea will never produce the leaf yields obtained from more traditional areas, it is thought likely that the challenging growing conditions will result in the production of flavour compounds which will contribute to unique teas. With funding support from Interface, the AI will help Norse Pilgrim Ltd establish a small area of tea on Shapinsay in 2019 and help it develop appropriate growing practices for these plants.

Elderberry fruit from the Institute's collection have become a popular ingredient in wines produced by the Orkney Wine Company.

7 Staff

The following people contributed to the work of the AI over the period:

Dr Peter Martin - Director
Mr John Wishart – Field, laboratory and technical support; supply chain management
Mr Billy Scott – Additional support
Dr Burkart Dieterich – RESAS research support

8 Publications

The following papers and reports were produced over this period by AI staff:

Blanz, M., Ascough, P., Mainland, I.L., **Martin, P.**, Taggart, M., **Dieterich, B.**, **Wishart, J.**, Sayle, K., Raab, A., Feldmann, J. (2019). Seaweed fertilisation impacts the chemical and isotopic composition of barley: Implications for analyses of archaeological skeletal remains. *Journal of Archaeological Science* 104, 34-44.

Wallace, M., Bonhomme, V., Russell, J., Stillman, E., George, T.S., Ramsay, L., **Wishart, J.**, Timpany, S., Bull, H., Booth, A., **Martin, P.** (2018). Searching for the Origins of Bere Barley: a Geometric Morphometric Approach to Cereal Landrace Recognition in Archaeology. *Journal of Archaeological Methods and Theory*. https://doi.org/10.1007/s10816-018-9402-2

Schmidt, S.B, George, T.S., Brown, L.K., Booth, A., **Wishart, J.**, Hedley, P.E., **Martin, P.**, Russell, J., Husted, S. (2018). Ancient barley landraces adapted to marginal soils demonstrate exceptional tolerance to micronutrient limitation. *Annals of Botany*. https://doi.org/10.1093/aob/mcy215

Martin, P. (2018). Barley returns to Raasay. SCRR Newsletter 91, 2.

Martin P, Wishart J (2018). Report to Forestry Commission Scotland on monitoring of Short Rotation Forestry trials in Orkney during 2018. Orkney College UHI.

Martin P, Wishart J (2018). Report for R&B Distillers on research in 2018 into growing barley on Raasay for Raasay Distillery. Orkney College UHI.

9 Contacts

For further information about the Agronomy Institute, contact:

Dr Peter Martin (Director)

Agronomy Institute,
Orkney College UHI,
Kirkwall,
Orkney,
KW15 1LX,
Scotland.

Tel: +44 (0)1856 569298
Fax: +44 (0)1856 569001

Email: peter.martin@uhi.ac.uk

https://www.uhi.ac.uk/en/research-enterprise/res-themes/silk/agronomy-institute/

@AgronomyUHI

AGRONOMY INSTITUTE


Isle of Raasay
2018
449
Distillery


Blootered.


AGRONOMY
INSTITUTE