



University of the
Highlands and Islands
Orkney College



AGRONOMY INSTITUTE

- For Northern Temperate Crop Research -

ANNUAL REPORT

(April 2020 to March 2021)



Orkney supply chain Bere barley close to harvest at Heatherbell, South Ronaldsay, in August 2020

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

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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 2020 to March 2021. During this period, AI research activities were concentrated on a Scottish Government funded heritage barley project in collaboration with the James Hutton Institute (JHI). Collaborations also continued with other researchers at the Universities of Copenhagen and Sheffield and Trinity College Dublin on Bere barley and with former partners in the Northern Cereals project. On the commercial side, the AI continued to manage a Bere barley supply chain to provide grain for malting to Bruichladdich Distillery and other end users, and collaboration continued with Raasay and Borders (R&B) Distillers to help it source high provenance malting barley for use by its new distillery on the Isle of Raasay. A project with Norse Pilgrim Ltd continued in 2020 to help the company grow tea on the island of Shapinsay while a new project started in 2021 with Orkney Craft Vinegar aimed at developing novel kombuchas flavoured with locally grown fruit. An exciting new development was the inclusion of a proposal for an Orkney Community Vertical Farm, based at the Institute, in the Islands Growth Deal which is scheduled to start in early 2022 and was signed by representatives of islands councils and the UK and Scottish Governments in March 2021.

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:

- *Research Organisations:* Agricultural Centre (Faroe Islands); Agricultural University of Iceland; MATIS (Icelandic Food and Biotech R&D); NIBIO (Norwegian Institute of Bioeconomy Research); Rothamsted Research; The James Hutton Institute (International Barley Hub and Advanced Plant Growth Centre); Trinity College Dublin (FoodCult project); the Universities of Copenhagen, Manchester and Sheffield.
- *Commercial Companies:* Bairds Malt; Bruichladdich Distillery; Crisp Malt; Intelligent Growth Solutions; Norse Pilgrim Ltd; Orkney Distilling Ltd; Orkney Craft Vinegar; Orkney Wine Company; R&B Distillers Ltd; Swannay Brewery; Warminster Maltings Ltd.
- *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.



Test brewing in the FoodCult project's reconstructed Tudor brewhouse in 2020.

AI staff participated in the 2020 Northern Periphery and Arctic Annual Conference and made an on-line presentation about the Northern Cereals project (see p. 7) in a session on *Innovation in the bio-based industry*.

4 Impact Of The Agronomy Institute

The Institute continues to make an impact at several levels:

- Growers 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 2020, for the fourteenth successive year, Orkney growers working with the Institute planted about 30 ha of Bere for specialist whisky and beer markets which the AI has developed and supplies. The success of this market has created a demand for Bere from other end users which has also allowed Birsay Heritage Trust expand its Bere supply chain to a similar scale. Since 2017, the Institute has been helping growers on Raasay and in other locations produce high provenance malting barley for whisky production by R&B Distillers' new distillery on the



Barley grown on Shapinsay for R&B Distillers as a result of collaborative links developed by the Agronomy Institute between the company and a local estate.





Isle of Raasay in the Inner Hebrides. 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. Since 2019, the Institute has been helping the Shapinsay company, Norse Pilgrim, develop its tea growing enterprise.

A range of products released by Scottish companies over the past ten years which were produced with assistance from the Agronomy Institute.

- 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 six 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 Orkney Wine Company has resulted in the release of three new wines and a liqueur, and both the Orkney Wine Company and Swannay Brewery developed successful cask-matured products using Bere whisky 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 on the island in trials run by the AI was distilled at the Isle of Raasay Distillery in both 2018 and 2019.

- 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, 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



Norse Pilgrim's tea plants at the end of their first year of growth in a polytunnel on the island of Shapinsay. The Institute has also raised more plants for the company from seed obtained from Nepal.



Institute and Forestry Commission Scotland) have helped these organisations deliver research projects benefiting remoter parts of the Highlands and Islands.

- 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 2021 Research Excellence Framework (REF).



Bere barley shortly after heading in July 2020. Bere is probably the oldest type of barley still in cultivation in Europe and it has a number of unique traits which have made it an important subject for transdisciplinary projects involving the Agronomy Institute, commercial companies and other research centres.

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 current research themes are reviewed below:

5.1 Early-Maturing Cereal Varieties

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 have included 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; some have also been tested on Shetland and 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 have been grown by the Institute between 2016 and 2021 as part of a collaborative project with the James Hutton Institute funded by the Scottish Government. This research has also included trials of populations of crosses between Bere and two modern varieties.



2020 trial on a nutrient-poor soil at Burray of a population of crosses between a modern barley variety, KWS Irina, and the traditional Scottish landrace, Bere.



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.

Between 2011 and 2018, the AI collaborated 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.



Flowers of Chilean guava (*Myrtus ugni*) on a plant in a trial plot at the Agronomy Institute in July 2020, two years after planting. A photograph of the fruit can be seen on page 9.

The AI continues to manage small areas of SRC and SRF at Muddisdale on the edge of Kirkwall.

5.3 Plants For Natural Products

Plants in this theme could have a wide range of end uses, but most of those investigated 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. Most recently, the Institute has started to investigate the local cultivation of tea (*Camellia sinensis*) with a grower on the Orkney island of Shapinsay.

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*



Fruit of seabuckthorn harvested from Agronomy Institute bushes in October 2020. While fruits are tart and refreshing, they are difficult to harvest.



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 2020/21 the AI was involved in the projects and commercial activities outlined in the following sections:

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 (especially Bere) 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 an important resource for the project.

The 2020 Orkney research programme included a trial on a manganese deficient field site at Burray. The trial consisted of 672 plots and investigated the field characteristics of an F6 population of crosses between Bere and a modern variety, KWS Irina. Lines in the F6 population demonstrated a considerable range of head type (6-row, 2-row and intermediate types), earliness of harvest, straw length and tolerance to the deficiency of soil manganese at the site.

Northern Cereals – New Markets For A Changing Environment

This project was funded by the Northern Periphery and Arctic Programme and included partners from Iceland (MATIS and the Agricultural University of Iceland), northern Norway (NIBIO), the Faroes (Agricultural Centre) and Newfoundland and Labrador (Forestry and Agrifoods Agency). 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 cereal markets and more added value products. Although the project ended in June 2018, several of the partners continued to collaborate and carried out an additional study on microbreweries. The results of this study, as well as a paper describing partner use of transnational and transdisciplinary methodologies for developing local barley to beer value chains in the Northern Periphery Programme area, were published in 2020 (see Section 8).



Drone photograph taken in June 2020 of the RESAS barley trial at Burray of a population of crosses between Bere and KWS Irina. Plots which are light yellow and thin are crosses which lack a tolerance to the site's manganese deficient soil.



Barley from the 2019 Raasay trial being malted by Crisp Malt using their floor malting facilities in October 2020. The malt will be used for distillation by Isle of Raasay Distillery in 2021.



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 was keen to source some of the barley used by the distillery locally but, since the crop had not been grown there for a long time, it approached the Institute to help it investigate the feasibility of doing this. The Institute selected very early maturing barley varieties from northern Europe for testing in on-farm variety trials which were established on Raasay between 2017 and 2019. In all three years, early maturing varieties were successfully grown and harvested and the barley has been malted and used by the distillery for whisky production. Further assistance to the company was provided in 2020 and 2021 to help it source high provenance barley from other Scottish locations for distilling.



Bere being collected from the Agronomy Institute's Weyland Farm to be taken to Crisp Malt for malting and subsequent use by Swannay Brewery and Orkney Craft Vinegar.

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. Methods under investigation include geometric modern morphometric (GMM) analysis of grains of Bere and other 6-row hulled barleys and genotyping by sequencing of Bere and other barley cultivars. It is hoped that this may provide information about the evolution of Bere and perhaps indicate the route by which it was introduced to Scotland and the period when this occurred.

FoodCult Project (<https://foodcult.eu/>)

This project brings together history, archaeology, science and information technology to explore the diet and foodways of diverse communities in early modern Ireland. The Institute is collaborating with experimental archaeologists on the project investigating brewing in the 16th century, and especially the nutritional value of beers of this period, which often included oats. Since Bere was grown in Ireland at this time, an important contribution of the Institute to the project has been to supply the Bere for brewing and information



Bere close to harvest at Heatherbell in South Ronaldsay. The crop is being grown for the Institute's Orkney Bere supply chain by Barrie and Victoria Moar. Beyond the field is Scapa Flow and the islands of Hunda and Hoy.



about the crop. The Bere will be malted by Warminster Maltings.

Supply Chain For Bere

For the fourteenth year, the AI ran a Bere supply chain with local growers and, following a good harvest, was able to supply 100 t of Orkney-grown grain to Bruichladdich Distillery for whisky production. Bruichladdich uses Bere to produce high provenance *Bere Barley* whiskies which are released as annual vintages. In 2019, *Bere Barley 2010* was released which was distilled in 2010 from the 2009 Orkney Bere crop. In 2020, the distillery started releasing single cask bottlings of Bere whiskies, the first being a 10-year-old selection of Bere distilled in 2009. Bere from the supply chain is also made into specialist products by other companies. These include Swannay Brewery and Orkney Craft Vinegar; it has also been supplied to a few other companies for product development work.



Nearly-ripe fruit of Chilean guava in November 2020. The Institute planted a small trial of this species in 2018. Although fruit are late maturing for Orkney conditions, they have a very attractive flavour.

6.2 Plants For Natural Products

Orkney Botanicals For Flavouring Gin

Orkney Distilling Ltd (ODL) was established in 2016 and since then the company has opened a new distillery and visitor centre at a site on the Kirkwall waterfront. Using a selection of locally grown botanicals produced by the Institute, the company developed its first product, *Kirkjuvagr* gin, later in the year. In 2017, the AI helped ODL establish a botanicals garden from where it sources some of its own botanicals.

Orkney Fruit Kombucha

Building on earlier links between the Institute and Orkney Craft Vinegar which helped the company develop its Bere Malt vinegar, the partners are working together in 2021 to develop fruit kombuchas. In line with the company's ethos, the fruit for these will be Orkney-grown and a range of the species under trial by the Institute will be tested in 2021.

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,



Two-year-old tea plants in a fertiliser trial at Orkney College established to support Norse Pilgrim Ltd's polycrub-based tea growing venture in Shapinsay.



aronia, elder and salal and flowers of elder, supplied by the Institute.

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 tea grown outside in Scotland will never produce the leaf yields obtained from more traditional areas, it is thought that the challenging growing conditions combined with long summer daylength could result in the production of uniquely flavoured teas which can be sold on the high value specialist tea market. With funding support from Interface, the AI helped the Shapinsay company, Norse Pilgrim Ltd, establish a small area of tea in a polycrub in 2019 and produced plants for the company which will be planted in 2021. The Institute is also helping the company develop appropriate growing practices for young tea under north of Scotland conditions.

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

8 Publications

AI staff contributed to the following publications:

Bertella, G., Halland, H., Reykdal, Ó., **Martin, P.** (2021). 16 - Sustainable value: the perspective of microbreweries in peripheral northern areas, Editor(s): Roberta Capitello, Natalia Maehle, In: Woodhead Publishing Series in Consumer Sci & Strat Market, Case Studies in the Beer Sector, Woodhead Publishing, pp 253-265.
<https://doi.org/10.1016/B978-0-12-817734-1.00016-1>

Halland, H., **Martin, P.**, Dalmannsdóttir, S., Sveinsson, S., Djurhuus, R., Thomsen, M., **Wishart, J.** and Reykdal, Ó. (2020). Transnational cooperation to develop local barley to beer value chains *Open Agriculture*, 5 (1) 138-149.
<https://doi.org/10.1515/opag-2020-0014>

9 Contacts

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