



University of the
Highlands and Islands
Orkney College



AGRONOMY INSTITUTE

- For Northern Temperate Crop Research -

ANNUAL REPORT

(April 2022 to March 2023)



Harvesting a trial field of Bere grown on North Uist for North Uist Distillery in September 2022

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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 2022 to March 2023. During this period, AI research activities were concentrated on Scottish Government funded projects on novel crops and heritage barley in collaboration with the James Hutton Institute (JHI), collaboration with the EU RADIANT project on Bere barley and helping North Uist Distillery test the feasibility of using locally grown Bere for whisky production. In addition, collaborations continued with other researchers at the Universities of Copenhagen, Sheffield, St Andrews and Trinity College Dublin on Bere. On the commercial side, the AI continued to manage a Bere supply chain to produce malt for 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 proposal for an Orkney Vertical Farm, based with the Institute, has been included in the Islands Growth Deal which was signed in January 2023.

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:



Delegates from the EU RADIANT project Bere Creator Workshop visiting a demonstration trial of Bere, other landraces and modern varieties at Orkney College UHI in July 2022.

- **Research Organisations:** The James Hutton Institute (International Barley Hub; Advanced Plant Growth Centre; EU RADIANT project); Trinity College Dublin (FoodCult project); the Universities of Birmingham, Copenhagen, Manchester, Sheffield, St Andrews, Stockholm and Swansea.
- **Commercial Companies:** Bairds Malt; Bruichladdich Distillery; Crisp Malt; Intelligent Growth Solutions; Norse Pilgrim Ltd; North Uist Distillery Ltd; Orkney Distilling Ltd; Orkney Wine Company; R&B Distillers Ltd; Swannay Brewery; Warminster Maltings Ltd.
- **Growers, Grower and End-User Groups and Trusts:** Balfour Castle Estate; Birsay Heritage Trust; Home Robertson Farming Partnership, Orkney Bere supply chain; Orkney Food and Drink.

In collaboration with researchers at JHI, AI staff organised and participated in the 2022 RADIANT project creator workshop on Bere which was hosted by Orkney College UHI in July 2022.

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 2022, for the sixteenth 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 to expand its Bere supply chain to a similar scale. From 2017, the Institute helped a grower on Raasay produce malting barley for whisky production by R&B Distillers' new distillery on the Isle of Raasay in the Inner Hebrides and in 2022 it helped a grower on North Uist



Orkney tea producer, Lynne Collinson of Norse Pilgrim Ltd, tasting the first tea made from shoots harvested in her polycrubb. The Agronomy Institute has helped her establish her tea growing enterprise since 2019.



produce a trial crop of Bere for North Uist 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. Since 2019, the Institute has been helping the Shapinsay company, Norse Pilgrim, develop its tea growing enterprise.

- 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 eight 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. In 2022, Norse Pilgrim Ltd produced its first teas, Norse Noir and Norse Ruby, made with its own leaf – these are the most northerly teas produced by Scotland’s nascent tea industry.

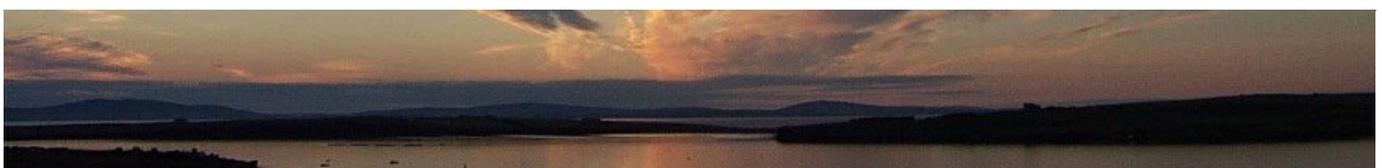


Norse Noir and Norse Ruby, the first teas produced by Norse Pilgrim Ltd, a new tea enterprise based on the Orkney island of Shapinsay and supported by the Agronomy Institute.

- 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), Raasay (R&B Distillers Ltd) and North Uist (North Uist Distillery) 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) have helped these organisations deliver research projects benefiting remoter parts of the Highlands and Islands.



The single malt whisky, Bere Barley 2012, released by Bruichladdich Distillery in August 2022. It is the eighth single malt Bere whisky released by the distillery, all of which have resulted from collaboration with the AI.



- 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 Unit of Assessment (UoA) 7 (Earth Systems and Environmental Sciences) in the 2021 Research Excellence Framework (REF). Overall, 33% of the research included in the UoA 7 submission was considered "world leading" and 51% was graded "internationally excellent".



Bere growing in North Uist in August 2022 as part of a feasibility study for North Uist Distillery into producing Bere locally for whisky.

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 since 2016 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 and have recently included landraces of Hebridean rye (*Secale cereale*) and Small oat (called Black oats in Orkney; *Avena strigosa*) from Scotland's Western Isles.



Orkney College trial of different types of barley on 24 June 2022. Conspicuously, several plots of Bere can be seen to have reached the heading stage before other barleys in the trial.

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. 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 for gin. Most recently, the Institute has investigated the local cultivation of tea (*Camellia sinensis*) with a grower on the Orkney island of Shapinsay.



A range of products made from Orkney Bere on display at the 2022 RADIANT project Bere workshop hosted by Orkney College in July 2022.

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 2022/23 the AI was involved in the projects and commercial activities outlined in the following sections:

6.1 Cereals

RESAS-funded research on Bere Barley (2022-2027)

The Scottish Government's Rural and Environmental Science and Analytical Services (RESAS) Division is funding two projects (BARGAIN and Novel Crops) co-ordinated by the James Hutton Institute which include a focus on Bere and involvement of the AI. Within the Novel Crops project, the AI is helping to understand both the farmer motivations and market forces which affect the adoption and utilisation of novel crops like Bere. The overall aim of the BARGAIN project is to increase the genetic diversity in the



Tea bushes being grown in one of the Agronomy Institute's polythene tunnels to investigate the pattern of shoot growth under northern temperate conditions and the response of plants to fertiliser.



breeding gene pool of barley by using landraces and wild relatives. AI research contributes to this by helping identify traits in Bere which have potential value for inclusion in new barley varieties.

The 2022 Orkney research programme for the RESAS project included two trials on contrasting soils (manganese deficient and manganese sufficient at Burray and Orkney College, respectively). The trials contained several accessions of Bere and other Scottish and modern barleys together with Small oat (also called Black oats) and Hebridean rye landraces. Several accessions of Bere as well as Small oat and Hebridean rye are able to tolerate the manganese deficient conditions at Burray while modern varieties usually fail without producing any grain.



RESAS barley trial on a manganese deficient soil at Burray. The photo shows the much poorer growth (poor leaf development and light green canopies) of modern varieties in the foreground compared with landraces of Bere and rye (taller, greener plants in the midground).

Farmer's Pride Project

The main objective of the EU Farmer's Pride project (2017-2021; [Farmer's Pride – Conserving plant diversity for future generations \(bham.ac.uk\)](https://www.bham.ac.uk)) was to establish a network of stakeholders and conservation sites to help coordinate *in situ* conservation of European plant genetic resources (PGR) and maximize their sustainable use by the user community. In support of the project, the AI helped the University of Birmingham carry out a survey of growers of Scottish cereal landraces designed to identify the scale of growing and the factors motivating farmers to grow landraces. The survey was conducted in 2018 and was the basis for a paper published in 2023 (Martin *et al.*, 2023a) and summarised below.

The study emphasised the importance of parts of the Outer Hebrides for *in situ* conservation of three cereal landraces (Bere; Small oat; Hebridean rye) which are grown in a mixture on the Machair to provide overwintering animal fodder. Machair is a coastal dune ecosystem of international importance and is characterised by sandy, high pH soil which is deficient in

manganese and other trace elements. The landraces within the mixture all have a tolerance to these conditions in contrast to modern varieties which fail to grow successfully on such soil. Furthermore, cultivation of the mixture with organic fertilisers, especially seaweed and manure, and appropriate fallow periods is crucial for conservation of the Machair's rich and distinctive flora and fauna. Successful examples of *in situ* conservation of Bere were also identified in Orkney, based upon commercial use of Bere grain for producing beremeal or malt which are then used for making high value food and drink products.

Although the continued growing of the cereal landrace mixture in the Outer Hebrides and of Bere in Orkney are encouraging for conservation, damage



Lesley McGeachy, senior tour guide at Bruichladdich Distillery, taking delegates to the RADIANT Bere workshop through a tasting of Bruichladdich's 2012 Bere whisky. Grain for the whisky is produced by an Orkney supply chain run by the AI and this contributes to the *in situ* conservation of Bere.



from geese are a major threat to continued landrace cultivation on the Outer Hebrides and there is now very little growing of Small oat on Orkney and both Bere and Small oat on Shetland. The factors motivating farmers to grow landraces were varied, but tradition, tolerance to poor soils and a market for the crop or on-farm use appeared to be most important.

Bere – a North Atlantic barley ?

The historic importance of Bere to both Scotland and Ireland is well documented, but recent research in which the AI has been involved has also suggested it may have been more widely distributed in the North Atlantic, possibly linked to the Norse settlements in this area. This is indicated by the genotypic and phenotypic similarity of two surviving Faroese barley landraces (Langaks and Stjernebygg) to Bere in contrast to the more distant relationship between Bere and other Scandinavian landraces (Drosou et al., 2022).

Although other explanations are

possible, this could have resulted from Bere having been taken to the Faroes by Norse settlers, some of whom originated from their colonies in Scotland and Ireland. In a similar way, Bere could have been taken to Iceland although barley cultivation in Iceland ended around 1500 and so there are no surviving Icelandic landraces for comparison with today's Bere.

Irrespective of whether the barley grown in Iceland and the Faroes from Viking times included Bere, it is very likely that it would have had very similar growth characteristics to Bere. With this assumption, a recent study (Martin *et al.*, 2023b) has combined grain production temperature thresholds for Bere with tree-ring based reconstructions of cropping season temperatures for the Scottish Isles, Iceland and the Faroes to investigate how temperature and other factors may have affected barley production in these areas over the past 800 years. In Iceland, the study identified protracted periods with cold cropping seasons when very poor grain production would have been likely during the 14th and 15th centuries and this may have influenced abandonment of barley cultivation around this time. It was also found that, although temperature conditions were more favourable in the Faroes and, especially, the Scottish Isles, there were still many years when poor harvests would have been likely and in the Scottish Isles many of these years



A recent study involving the AI combined physiological data from modern Bere crops (left) with temperature reconstructions based on tree-ring (top) data from from a network of Scots Pine (*Pinus sylvestris*; right) sites to investigate the suitability of temperature conditions over the past 800 years for barley production on Iceland, the Faroes and the Scottish Isles.



Lewis Hill, from Swannay brewery in Orkney, talking to delegates from the RADIANT project workshop about the company's use of Bere for brewing. Since 2004, the AI has developed new brewing and distilling markets for Bere which have helped strengthen its *in situ* conservation.



corresponded with historic reports of famine or crop failure. Continued barley cultivation in both the Faroes and Scottish Isles over the past 800 years demonstrates considerable resilience in production systems.

Supply Chain For Bere

For the sixteenth year, the AI managed 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* single malt whiskies which are released as annual vintages. In 2022, *Bere Barley 2012* was released which was distilled in 2012 from the 2011 Orkney Bere crop. 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.



Trial field on North Uist just after sowing, showing the typical sandy soil associated with arable Machair land. These soils have a high pH and are deficient in manganese and other trace elements. The Scottish cereal landraces Bere, Small oat and Hebridean rye all have a remarkable ability to grow successfully on such soils.

North Uist Distillery

With funding from the Scottish Food and Drink net zero challenge fund, the AI helped North Uist Distillery (NUD) investigate the feasibility of growing Bere on North Uist for whisky production. A collaborating farmer successfully produced 1.5 t of Bere which will be used in 2023 to further multiply the distillery's stock of seed.

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. The Institute continues to provide samples of some of the species it grows to the distillery for testing in its gins.

Northern Fruit Species 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.



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 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 and from UHI's Tourism Challenge Fund, 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 were planted in a small test area outside in 2021. The Institute has also helped the company develop appropriate growing practices for young tea under north of Scotland conditions and in 2022 the company was able to send shoots for processing and to start selling its first Orkney tea.



Tea made from shoots harvested in Orkney by Norse Pilgrim Ltd in Shapinsay and processed at The Scottish Tea Factory. The AI has been helping Norse Pilgrim to grow tea since 2019.

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 peer reviewed publications:

Drosou K, Craig H, Palmer K, Kennedy SL, **Wishart J**, Oliveira HR, Civián P, **Martin P**, Brown TA (2022). The evolutionary relationship between bere barley and other types of cultivated barley. *Genetic Resources and Crop Evolution* 69, 2361-2381. <https://doi.org/10.1007/s10722-022-01377-8>

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Schmidt, S.B., Brown, L.K., Booth, A., **Wishart, J.**, Hedley, P.E., **Martin, P.**, Husted, S., George, T.S., Russell, J. (2023). Heritage genetics for adaptation to marginal soils in barley. *Trends in Plant Science*. 2023 Feb 27. <https://doi.org/10.1016/j.tplants.2023.01.008>



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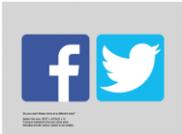
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