University of the Highlands and Islands Orkney College

AGRONOMY INSTITUTE

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- For Northern Temperate Crop Research -

ANNUAL REPORT

(April 2019 to March 2020)

Harvesting the Institute's barley trial on Raasay in August 2019

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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 2019 to March 2020. 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 on Bere barley, with Rothamsted Research on willow and with former partners in the Norther 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 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

Demonstration plot of Orkney Bere grown by the National Institute of Agricultural Botany (NIAB) for their 2019 Innovation Farm event in Cambridge.

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); NIAB (National Institute of Agricultural Botany); 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; 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 two knowledge exchange events funded through the SEFARI Gateway. The first of these was a Field Lab event on Lismore where the Institute outlined its research and commercial activities with Bere and other heritage and early maturing varieties. The second event focused on sustainable barley discussions as part of the The James Hutton Institute's Barley Away Days.

4 Impact Of The Agronomy Institute

John Wishart (left) of the Agronomy Institute and Marty Hay (right) of Birsay Heritage Trust discuss lodging of Bere in one of the Trust's fields overlooking the Loch of Boardhouse in late July 2019.

The Institute continues 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 2019, for the thirteenth 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. For the third year, on the Inner Hebridean island of Raasay, the Institute helped a farmer 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. In 2019, the Institute helped the Shapinsay company, Norse Pilgrim, to develop its tea growing enterprise.

Bere barley 2010 (left), a single malt whisky made by Bruichladdich Distillery using Bere supplied by the Agronomy Institute, was released in 2019. Boxes of Bere whisky (right) being prepared for despatch from the distillery's bottling hall.

- 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, *Kirkjuvag*r 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 malted and distilled at 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, 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) have helped these organisations deliver research projects benefiting remoter parts of the Highlands and Islands.

In a new collaboration with the Shapinsay company, Norse Pilgrim, the Institute germinated seeds of tea and raised seedlings for the company; these will be planted in 2021.

- 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:

Raasay barley variety trial on 29 July 2019. The trial tested the very early maturing variety *Iskria* (foreground) and the slightly later maturing variety Brage (middle).

5.1 Early-Maturing Cereal Varieties

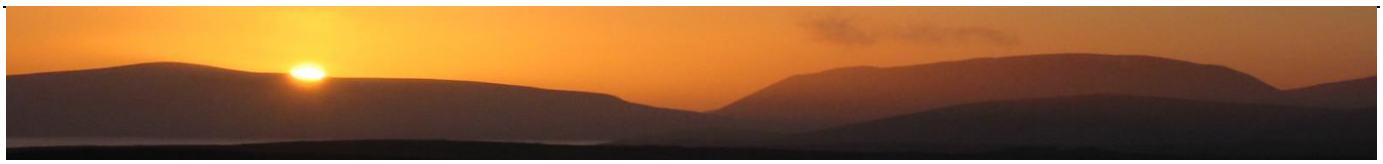
Under this theme, the Institute is investigating both modern and heritage cereal varieties which are early-maturing and therefore suited to growing in the Highlands and Islands' short, cool growing season. They are mainly being considered for food and drink products and have included varieties of barley, 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 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. In 2019, this research was expanded to include a trial of a population of crosses between Bere and a modern variety.

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

Nine-year-old stems of SRC willow at Muddisdale in August 2019. These are now about 4-6 m tall with a diameter of up to 6.5 cm at breast height. In 2019, collaboration continued with Rothamsted Research to investigate the chemical composition of willow grown in Orkney.



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.

Apart from fruiting well under Orkney conditions, aronia produces attractive scarlet foliage in the Autumn. Unfortunately, in Orkney, leaves are soon lost with the onset of September gales.

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. 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 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 2019/20 the AI was involved in the projects and commercial activities outlined in the following sections:

View from the Institute's small plot combine during harvesting of the 2019 RESAS barley trial in September. This contained 360 plots which were individually harvested.

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.

Photograph taken from a drone on 20 June 2019 of a trial on a sandy, manganese-deficient soil in Burray. The trial included 17 modern barley varieties and two accessions of Bere with a tolerance to low soil manganese. In contrast to the sickly, yellow appearance of the modern varieties, the 6 plots of Bere (indicated by red arrows) were dark green and healthy.

The 2019 Orkney trials programme included two trials, one at Orkney College and the other at Burray. The trial at Orkney College consisted of 360 plots and investigated the field characteristics of the F6 population resulting from crosses between Bere and Concerto. Lines in the F6 population demonstrated a considerable range of head types (6-row, 2-row and intermediate types), ear maturity dates and straw length indicating that the crossing was very effective at re-distributing the genes from Bere and Concerto.The trial at Burray was on a manganese deficient sandy soil and investigated the growth of two accessions of Bere with a tolerance to low levels of soil manganese and 17 modern barley varieties on the AHDB Recommended List. The trial dramatically demonstrated that none of the modern varieties had any tolerance to the nutrient-deficient soil conditions and all failed to produce a harvestable crop of grain. In contrast, the two accessions of Bere grew and yielded normally (see photo above).

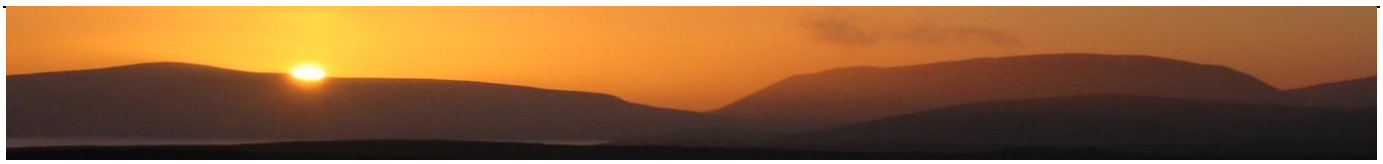
Northern Cereals – New Markets For A Changing Environment

This project was funded by the Northern Periphery and Arctic Programme and included partners from Iceland (MATIS and 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 have continued to collaborate and have carried out one further study on microbreweries. They have also had a manuscript accepted for publication describing their use of transnational and transdisciplinary methodologies for developing local barley to beer value chains in the Northern Periphery Programme area.

Malt made from barley harvested from the 2018 Raasay trial being added to the mash tun prior to distillation at Isle of Raasay Distillery in August 2019.

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. The Institute therefore 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 harvested barley has been used by the distillery for whisky production. This research has been supported by assistance from the James Hutton Institute.

With much attention being given to the development of new commercial products using Bere grain, it is often forgotten that its straw is also a very valuable commodity used as feed and bedding for livestock. This is often of very good quality because Bere is harvested early and its straw is therefore usually drier than that from later maturing crops.

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. One area of investigation is whether geometric modern morphometric (GMM) analysis can be used to identify a distinctive Bere signature in samples of dated 6-row hulled barley grains from 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.

Supply Chain For Bere

For the thirteenth year, the AI ran a Bere supply chain with local growers and, following a reasonable 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.

Harvesting Bere at Inganess Farm with the wreck of the tanker, Juniata, in the background. The dishevelled appearance of the Bere is typical of the crop by harvest and results from its weak stems which make it very susceptible to lodging and brackling.

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 and company are currently collaborating to develop new gins based upon some of the Institute's northern fruit species.

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.

Calamondin (*Citrus x microcarpa*) grows and fruits well in glasshouses in Orkney. Fruits are supplied by the Institute to Orkney Distilling Ltd for flavouring its Kirkjuvagr gin.

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 that the challenging growing conditions will 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, to establish a small area of tea in a polycrub in 2019 and to raise seedlings which will be planted in 2021.

7 Staff

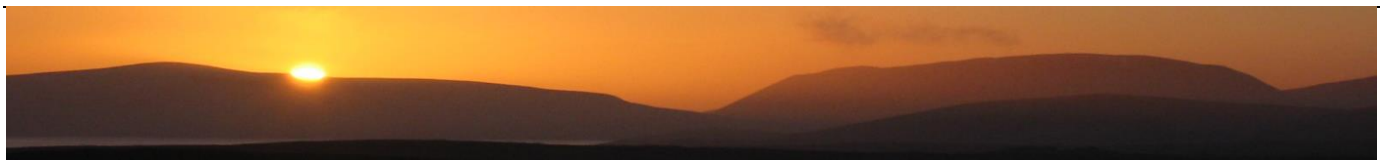
The following people contributed to the work of the AI over the period:

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

Norse Pilgrim's polycrub in Shapinsay containing a raised bed of tea. The Institute helped the company by designing the raised bed and preparing an acidic soil mix which is required by tea.

8 Publications

AI staff produced, or contributed to, the following publications and reports:



George, T., Russell J., Martin, P. (2019). Bere, an ancient crop that could increase agricultural sustainability. SCRR Newsletter 93, 5.

Martin P, Wishart J (2019). Report for Norse Pilgrim Ltd on research in 2019 into growing tea on Shapinsay. Orkney College UHI.

Martin P, Wishart J (2019). Report for R&B Distillers on research in 2019 into growing barley on Raasay for Raasay Distillery. Orkney College UHI.

9 Contacts

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