University of the Highlands and Islands Orkney College

AGRONOMY INSTITUTE

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- For Northern Temperate Crop Research -

ANNUAL REPORT

(April 2017 to March 2018)

Barley variety trial on Raasay in July 2017

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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 2017 to March 2018. 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. Other research collaborations also continued with the JHI on legumes and berries and with Forestry Commission Scotland on short rotation forestry. On the commercial side, the AI continued to manage a Bere barley supply chain to provide grain for malting to both Bruichladdich Distillery and Swannay Brewery. A new collaboration with Raasay and Borders (R&B) Distillers, to investigate the feasibility of sourcing local barley for their new distillery on Raasay, started in 2017 and is continuing in 2018.

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 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 collaborative links 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:

John Wishart talking to visitors about barley accessions in the Agronomy Institute's heritage barley trial during a Bere knowledge exchange event at Orkney College in June 2017.

- *Research Organisations:* Agricultural Centre (Faroe Islands); Agricultural University of Iceland; Forestry and Agrifoods Agency (Government of Newfoundland & Labrador, Canada); Forestry Commission Scotland; MATIS (Icelandic Food and Biotech R&D); NIBIO (Norwegian Institute of Bioeconomy Research); Rowett Institute of Nutrition and Health; The James Hutton Institute (Invergowrie, Dundee); and the Universities of Copenhagen, Manchester and Sheffield.
- *Commercial Companies:* Bairds Malt; Bruichladdich Distillery; Crisp Malt; Highland Park Distillery; Lantmännen SW Seed AB; Orkney Distilling Ltd; Orkney Craft Vinegar; Orkney Wine Company; R&B Distillers Ltd; Swannay Brewery; Valhalla Brewery.
- *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 a number of prominent knowledge exchange events. These included: a joint event in Orkney on Bere with the JHI in June 2017; an open event on Raasay with R&B Distillers in July 2017 and a joint presentation with the company about the AI and Raasay Distillery's collaborative barley research programme on Raasay at the 2018 Scottish Knowledge Exchange Awards. Two presentations about AI research and commercialisation activities with barley were made in Iceland at the annual conference of the Northern Cereals project, and the Institute presented information on Bere to a group of over 20 Bruichladdich Brand Ambassadors at the distillery in March 2018. The AI's Bere supply chain activities were included in an edition of *On Your Farm* (BBC Radio 4) and in an article in *Country Lifestyle Scotland,* celebrating Scottish whisky production in the Year of History, Heritage and Archaeology.

Sydney Gauld (centre), a grower of Bere for the Agronomy Institute's supply chain, with Sarah Swadling (left) and Tom Heap (right) making a programme on Bere for BBC Radio 4's *On Your Farm*.

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 2017, for the eleventh successive year, Orkney growers planted about 30 ha of Bere for a specialist whisky market which the AI has helped to develop while on the Inner Hebridean island of Raasay the Institute helped a farmer produce the first crop of barley for malting in living memory. In 2015 the Institute assisted the Orkney Wine Company to establish its own plantation of novel fruits which the company uses for making wines and liqueurs, while in 2017 it helped Orkney Distilling Ltd establish its own botanicals garden which contains plants for flavouring gin. In September 2017, the Institute helped to organise a visit by 24 farmers from the Faroese Farmers' Association to a range of businesses in the Orkney agricultural sector.

- Commercial companies have also benefited as crops have been made available for the development of new products. Thus, between 2012 and 2014, Isle of Arran Distillers produced two limited edition Bere whiskies, since 2014 Bruichladdich Distillery has released the first four 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. On Raasay, barley produced in AI trials run for R&B Distillers will be used for malting in 2018 and will be distilled at the new Raasay Distillery. Orkney's Barony Mill has produced wheat flour and oatmeal from locally grown crops initially trialled by the AI and these are being used in bakery products by local companies. Through its involvement in the Northern Cereals project, the AI has helped promote links between Scottish companies and those in other partner regions. A particularly popular initiative arranged by the Institute has been placements at Highland Park distillery, to learn traditional floor malting techniques.

Botanicals garden planted in 2017 by the Agronomy Institute for Orkney Distilling Ltd to provide the company with a source of locally grown flavourings for gin.

- 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.

Staff of R&B Distillers and local stakeholders at an open event at the barley variety trial on Raasay in July 2017.

- 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. AI staff have made important recent 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:

Heritage barley trial at Orkney College in late July. The trial included a range of early-maturing landraces as well as many accessions of Bere.

5.1 Early-Maturing Cereal Varieties

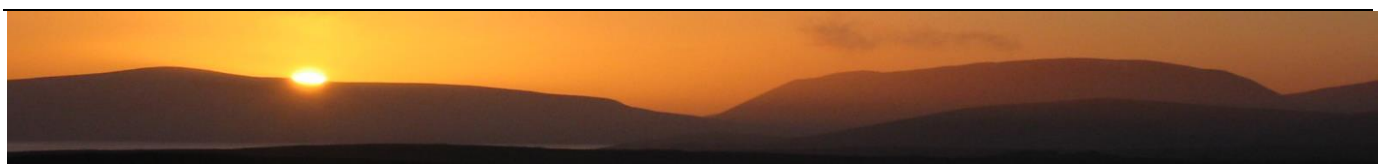
Under this theme, the Institute is investigating both modern and heritage cereal varieties which are early-maturing and therefore suited to growing in the Highlands and Islands' short, cool growing season. They are mainly being considered for food and drink products and include varieties of barley, wheat 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 are now being 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 have been grown at Orkney College since 2016 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 aspen, about 2 m tall, in the short rotation forestry trial at Muddisdale.

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.

Roots of marshmallow harvested after two years growth at Orkney College in 2017. This was one of the botanicals investigated as a possible flavouring for *Kirkjuvag*r gin.

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 2017/18 the AI was involved in the projects and commercial activities outlined in the following sections:

Trial of selected Bere accessions and modern varieties on a mineral-deficient soil at Burray. Modern varieties (yellowish, stunted plants in the foreground) grew and yielded very poorly compared with adjacent plots of Bere (all at the heading stage).

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 2017, the research was extended to include a sandy nutrient-deficient site where tolerance to manganese deficiency was investigated in collaboration with the University of Copenhagen. The latter trial demonstrated remarkable tolerance amongst some Bere accessions to the site's mineral deficiency compared with the extremely poor growth of several modern varieties.

Northern Cereals – New Markets For A Changing Environment

This project started in June 2015 and is funded by the Northern Periphery and Arctic Programme. Other partners in the project include 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 is to increase cereal production in the partner regions in order to promote greater self-reliance and to facilitate the development of new markets. The project builds on the collaboration and experience developed by the partners in an earlier NORA-funded cereal project.

Northern Cereals project associate partners from R&B Distillers, Highland Park Distillery, Eimverk Distillery and Bruichladdich Distillery exchanging ideas on distilling in a visit to Eimverk Distillery during the 2018 project conference in Reykjavik.

Within the project, the AI leads work packages on beverages and market analysis. In 2017, it co-ordinated a study by the partners into the effects of recent warming on temperatures during the barley growing season and the effects this has had on growing the crop across the North Atlantic Region; it also produced several guidelines, case studies and reports for the project. Help was given to Swannay Brewery to source Bere malt, so that it could continue production of *Scapa Bere* and to Orkney Craft Vinegar to source Bere whisky casks and Orkney-grown fruit for producing its vinegar. It has participated in several knowledge exchange events aimed at promoting cereal growing in the Highlands and Islands and has helped to build up collaborative links between beverage companies across the region.

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, started in 2017, therefore included early-maturing varieties from northern Europe. Results from 2017 demonstrated that these could be harvested in August and it is intended to malt some of this grain and use it for distilling on Raasay in 2018. The trials are being continued in 2018 and benefit from collaboration with JHI and the Agriculture and Horticulture Development Board.

Billy Scott harvesting Bere from the variety trial on Raasay in August 2017.

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 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. So far, a range of grains from archaeological sites has been sourced, morphometric techniques are being assessed at the University of Sheffield and DNA extraction is being attempted at the University of Manchester. 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.

Harvesting Bere from Agronomy Institute fields on Weyland Farm in August 2017.

Supply Chain For Bere

For the eleventh year, the AI ran a Bere supply chain with local growers and, for the first time, over 100 t of Orkney-grown grain was supplied to Bruichladdich Distillery and Swannay Brewery. Bruichladdich uses Bere to produce a series of vintages of high provenance whiskies and in 2017 it released the fourth one (*Bere Barley 2008*) which has resulted from this collaboration. In this case, the Bere was grown on Islay with seed supplied by the Institute. Swannay Brewery uses Bere in a recently developed beer, *Scapa Bere*, which was first released in bottled form in 2017.

6.2 Woody Biomass

Casks of Bere spirit maturing in one of Bruichladdich Distillery's new warehouses on Islay. The spirit was distilled in January 2018 using the 2017 Orkney crop.

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 2017 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 (http://scotland.forestry.gov.uk/supporting/strategy-policy-guidance/climate-change-renewable-energy/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 2017 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.

Angelica plants flowering and setting seed at Orkney College. Younger plants are harvested when roots are required as a flavouring.

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.

Viking Red, a new wine released by the Orkney Wine Company using fruit grown by the AI.

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:

Martin P, Dalmannsdottir S, Gerdinum J, Halland H, Hermannsson J, Kavanagh V, MacKenzie K, Reykdal Ó, Russell J, Sveinsson S, Thomsen M, Wishart J. (2017). Recent warming across the North Atlantic region may be contributing to an expansion in barley cultivation. *Climatic Change*145: 351-365.

Martin P, Wishart J (2017). Cultivation and processing guidelines for plants grown by Orkney Distilling Limited as botanicals for flavouring gin. Orkney College UHI.

Martin P, Wishart J (2017). Report to Forestry Commission Scotland on monitoring of Short Rotation Forestry trials in Orkney during 2017. Orkney College UHI.

Martin P, Wishart J (2017). Report for R&B Distillers on the feasibility of growing barley on Raasay for Raasay Distillery. Orkney College UHI.

9 Contacts

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