AGRONOMY INSTITUTE
- For Northern Temperate Crop Research -

ANNUAL REPORT
(April 2016 to March 2017)

Collecting tissue samples from a heritage barley trial at Orkney College in June 2016

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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 2016 to March 2017. During this period, AI research activities were concentrated on a Scottish Government (RESAS) funded heritage barley project in collaboration with the James Hutton Institute (JHI) and a Northern Cereals project with researchers from other north European countries funded by the Northern Periphery and Arctic Programme. Research was also undertaken with the JHI on legumes, willows and berries and collaboration continued with Forestry Commission Scotland on short rotation forestry. On the commercial side, the AI continued to manage barley supply chains for Bruichladdich and Highland Park distilleries which produced about 100 t of grain for making into specialist whiskies. New commercial collaborations were started during the year to assist Orkney Distilling Ltd identify and produce local botanicals for flavouring gin and with Raasay and Borders (R&B) Distillers to investigate the feasibility of sourcing local barley for their new distillery on Raasay.

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

John Wishart (left) from the Agronomy Institute with project partners at the 2016 annual meeting of the Northern Periphery and Arctic Programme's Northern Cereals project in the Faroes.

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; Forestry and Agrifoods Agency (Government of Newfoundland & Labrador, Canada); Forestry Commission Scotland; Institute of Biological, Environmental and Rural Science (Aberystwyth University); MATIS (Icelandic Food and Biotech R&D); NIBIO (Norwegian Institute of Bioeconomy Research); Rowett Institute of Nutrition and Health; The James Hutton Institute (Craigiebuckler, Aberdeen and Invergowrie, Dundee); University of Manchester; University of Sheffield.

- *Commercial Companies:* Bairds Malt; Bruichladdich Distillery; Crisp Malt; Highland Park Distillery; Lantmännen SW Seed AB; McCreath, Simpson & Prentice Ltd; Orkney Distilling Ltd; Orkney Wine Company; R&B Distillers Ltd; Swannay Brewery; Valhalla Brewery.

- *Growers, Grower and End-User Groups and Trusts:* Balfour Castle Estate; Birsay Heritage Trust; Mains of Loirston Charitable Trust; Orkney Bere supply chain; Orkney Tartan supply chain; Orkney Food and Drink; SAC Consulting; Scotch Malt Whisky Society.

Orkney growers of Tartan malting barley with staff of the Edrington Group, Highland Park distillery and the Agronomy Institute at the annual meeting of the Tartan supply chain in February 2017.

The AI was involved in several knowledge transfer events including hosting a visit by farmers from New Aberdour and an open event at the heritage barley trial in August. A presentation about the Institute's commercialisation activities with Bere was made at the James Hutton Institute's annual Barley Away Day while the Institute's collaboration with the Orkney Wine Company was covered on STV (Scottish Television) news. Its collaboration with growers and distilleries was included in an article in *Unfiltered*, the magazine of the Scotch Malt Whisky Society.

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 transfer activities, particularly with cereals. In 2016, for the tenth successive year, Orkney growers planted about 25 ha of Bere for a specialist whisky market which the AI has helped to develop. Another group of

five Orkney growers grew 12 ha of modern malting barley for the seventh year to supply Highland Park Distillery with local malting barley. 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 developed with help from the Institute. Following successful research for Orkney Distilling Ltd into botanicals for flavouring gin, the Institute is helping the company establish its own botanicals garden for supplying flavourings for gin in 2017.

- Commercial companies are also benefiting as crops are being made available for the development of new products. Thus, as a result of AI collaboration, two new whiskies have been produced by Isle of Arran Distillers, the first three of a series of Bere whiskies have been released by Bruichladdich Distillery and Shetland's Valhalla Brewery continues to produce a beer (*Island Bere*) first made from Orkney Bere in 2006. 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. Collaboration between the AI and the Orkney Wine Company has resulted in the release of two new wines and a liqueur since 2012 while assistance from the Institute has also helped Orkney's Swannay Brewery develop two new beers, *Scapa Bere* and *Yardsook*, from locally grown cereals. Both the Orkney Wine Company and Swannay Brewery have also 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. Through its involvement in the Northern Cereals project, the AI has helped promote links between Orkney 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.

Kirkjuvagr gin and some of the Orkney-grown botanicals supplied by the Agronomy Institute which have contributed to its unique flavour.

- 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 AI'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 most recently 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.

Rob and Lewis Hill of Swannay Brewery inspecting a new consignment of Bere malt made by Crisp Malt and supplied to Swannay Brewery by the Agronomy Institute for new product development activities.

- With an aspiration for both national and international recognition, it is crucial, not only that the AI has international links (see Section 3) and is involved in trans-national projects (e.g. the Northern Periphery and Arctic Programme), but

also that its research output is of a high quality and contributes significantly to UHI. AI staff have made important recent contributions to research on cereals, willow and natural products and the Institute was part of UHI's submission to the 2014 Research Excellence Framework (REF).

5 Plant Research Themes

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

5.1 Early-Maturing Cereal Varieties

Burtons Malting, an English 2-row barley landrace with an unusually dense arrangement of grains in the head (zeocriton).

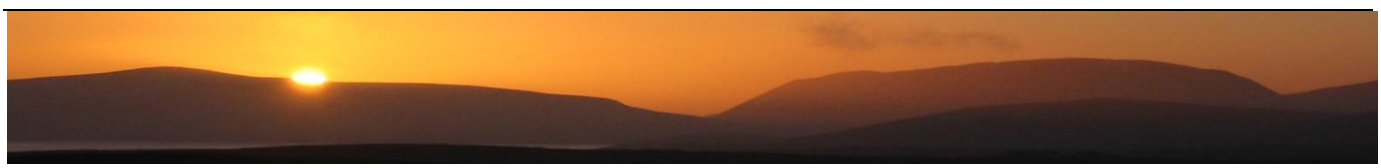
Under this theme, the Institute is investigating both modern and heritage cereal varieties which are early-maturing and therefore suited to growing in the Highlands and Islands' short growing season. They are mainly being considered for food and drink products and include varieties of barley, wheat and oats. Northern varieties from Scandinavia are thought to be very suitable for the north of Scotland, and Finnish, Swedish and Norwegian varieties have been grown successfully in Orkney for several years. The AI has also tested several UK varieties of malting barley and identified some which are early and also have potential for the Highlands and Islands. 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 types have been grown at Orkney College since 2016 as part of a collaborative project with the James Hutton Institute on heritage barley.

5.2 Woody Biomass Crops

Willow stems from Agronomy Institute plots of willow were used to build the frame of a replica Neolithic boat which featured in the BBC Two documentary series *Britain's Ancient Capital: Secrets of Orkney*.

These are being investigated as a possible source of local renewable heating fuel to help reduce dependence on fossil fuels. Initial AI research into biomass crops investigated the potential for using willow (*Salix* spp) grown as short rotation coppice (SRC), and willow trials were planted in 2002, 2006 and 2007.

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 the pharmaceutical and cosmetic market. 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*) and meadowsweet (*Filipendula ulmaria*) have been grown as flavourings.

Flowers of meadowsweet growing at Orkney College in 2016. 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 2016/17 the AI was involved in the projects and commercial activities outlined in the following sections:

Sheaves of barley accessions from the 2016 heritage barley trial drying prior to threshing.

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 Division (RESAS). 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. The Institute provides the project with an Orkney trial site and research facility which is particularly valuable as many of the Bere accessions originate from the Northern Isles.

The Orkney trial programme includes: 39 accessions of Bere (including 18 which have an Orkney or Western Isles provenance); 7 accessions of other Scottish landraces; 15 accessions of Scandinavian landraces; 42 accessions of non-Scottish British landraces; and 12 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 for mineral analyses and genotyping. In 2017, the research is being extended to include a sandy nutrient-deficient site where tolerance to manganese deficiency will be investigated in collaboration with the University of Copenhagen. An important result from the 2016 trial was that it indicated differences between the Bere accessions in the time taken to reach heading and grain maturity.

Northern Cereals – New Markets For A Changing Environment

This project started in June 2015 and is funded by the Northern Peripheries 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 & 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.

Steeping Bere for malt in Crisp Malt's pilot vat. The final malt was supplied to Swannay and Valhalla breweries.

Within the project the AI leads work packages on beverages and market analysis. Orkney collaborators in the project include Highland Park distillery, Swannay Brewery, Birsay Heritage Trust and Orkney Food and Drink. During 2016, the AI helped Swannay Brewery source Bere malt for new product development. This was made by Crisp Malt and some of the malt was also supplied to Valhalla Brewery in Unst, Shetland so that the brewery could continue production of *Island Bere*. During the year, Swannay Brewery also used some of the malt made from Orkney-grown 'Golden Promise' barley in 2015, with help from the Institute, in their *Old Norway* 8% ABV barley wine.

R&B Distillers Ltd (Isle of Raasay Distillery)

Raasay and Borders (R&B) Distillers Ltd encompasses two whisky distilleries, one in the Borders and the other on the Hebridean island of Raasay, near Skye. Both distilleries are being developed and the one on Raasay is scheduled to open in summer 2017. It will be the first legal distillery on the island and the company is keen for the whisky to have as high a local content as possible. In 2017, the Institute is helping the company and local farmers investigate the feasibility of growing barley on Raasay for the distillery. This will be done by testing several different varieties, including some of the early maturing varieties the Institute has previously worked with.

Development of the new Isle of Raasay Distillery (right) and members' accommodation (left), with the Cuillin Hills of Skye in the background.

Researching The Origins Of Bere

This is an initiative which is being developed 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, Bradford, Cambridge and Durham and molecular geneticists at the

James Hutton Institute. The collaboration is investigating whether grain morphometric and 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.

Supply Chain For Bere Whisky (Bruichladdich Distillery)

For the tenth year, the AI managed a supply chain with local growers which produced about 50 t of Orkney-grown Bere for Bruichladdich distillery. This is being used to produce a series of high provenance Bere whiskies. *Bere Barley 2009*, the second whisky made from Bere supplied by the Orkney supply chain, was released in 2016.

Preparing to plant Sydney Gauld's field at Quoyberstane, St Ola with Bere in April 2016.

Supply Chain For An All-Orkney Whisky (Highland Park Distillery)

Between 2009 and 2017, the AI collaborated with Highland Park distillery to help it produce an "all-Orkney" whisky. The project started with a malting barley variety trial run by the AI in 2009 which identified the variety Tartan as having a good combination of agronomic and malting characteristics under Orkney conditions. The distillery then asked the AI to develop a local supply chain for growing the variety and from 2010 to 2016 five local farms each grew 2.0-2.5 ha of Tartan annually. Over 7 years, the supply chain produced about 350 t of grain for Highland Park which has been malted and distilled at the distillery. The spirit is now maturing on-site, in the distillery's warehouses.

6.2 Woody Biomass

Short Rotation Forestry (SRF) Project

Since 2011, the AI has been collaborating with Forestry Commission Scotland (FCS) in a project to investigate the potential of SRF in Orkney. As part of the project, two SRF trials were established in 2013, one at Muddisdale near Kirkwall and the other at Newfield on the island of Shapinsay. Both trials contain the same nine species (sycamore, *Acer pseudoplatanus*; Italian alder, *Alnus cordata*; common alder, *Alnus glutinosa*; downy birch, *Betula pubescens*; beech, *Fagus sylvatica*; aspen, *Populus tremula*; goat willow, *Salix caprea*; mountain ash, *Sorbus aucuparia*; whitebeam, *Sorbus intermedia*). Monitoring of the trials continued in 2016 in collaboration with FCS and results from the trials are being included with those from others established by the Forestry 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 2016 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.

View of the Muddisdale SRF trial in June 2016 when trees were starting their fourth year in the field. The trees in the foreground are aspen.

Potential Of SRC For Treating Water In Orkney (Scottish Water)

This study was undertaken for Scottish Water by the Agronomy Institute in collaboration with researchers at the James Hutton Institute in Aberdeen. The study utilised the results and experience of the AI in growing SRC willow in Orkney and combined it with the modelling expertise of the JHI researchers who produced a water balance model for the crop under Orkney conditions. Although willow has a reputation for high water use, the model indicated that there were limited opportunities for irrigation with wastewater because of the frequency of rain in Orkney over the summer months.

Root of angelica (*Angelica archangelica*), an important ingredient in *Kirkjuvagr* gin. Seed for the plants grown by the AI came from a naturalised stand growing in Westray.

6.3 Plants For Natural Products

Orkney Botanicals For Flavouring Gin

2016 saw the establishment of a new Orkney company, Orkney Distilling Ltd (ODL), which is building a new distillery and visitor centre on the Kirkwall waterfront. In collaboration with Strathearn Distillery and with help from the Institute, the company developed its first product, *Kirkjuvagr* gin, in 2016. The gin includes a range of locally grown botanicals identified and grown for it by the Institute. One of the key botanicals in the gin is local 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. In 2017, the AI is helping ODL establish a botanicals garden where it will produce its own locally grown botanicals.

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 Institute 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* and *Orkney Rosé* and the liqueur *Kvasir.* These products include fruits of cranberry, aronia, elder and salal and flowers of elder, all supplied by the Institute.

Billy Scott (right), Head of Orkney College UHI's Agriculture Department, together with SVQ Level 2 Agriculture students in front of the tractor purchased for the Institute and Agriculture Department with assistance from the Mains of Loirston Charitable Trust.

7 Machinery

The AI frequently collaborates with Orkney College's Agriculture Department and the two units often share machinery where this is feasible. In 2016, the Mains of Loirston Charitable Trust provided a grant to the two units which helped them to purchase a tractor for research and teaching activities.

8 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

9 Publications

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

Chappell A, Scott KP, Griffiths IA, Cowan AA, Hawes C, Wishart J, Martin P (2017). The agronomic performance and nutritional content of oat and barley varieties grown in a northern maritime environment depends on variety and growing conditions. *Journal of Cereal Science* 74: 1-10.

Martin P (2017). Report to Highland Park Distillery on the performance of an Orkney supply chain for malting barley in 2016. Orkney College UHI.

Martin P, Wishart J (2016). Report for Orkney Distilling Limited on Potential Orkney-Grown Botanicals for Flavouring Gin. Orkney College UHI.

Martin P, Wishart J (2016). Report to Forestry Commission Scotland on Monitoring of Short Rotation Forestry Trials In Orkney During 2016. Orkney College UHI.

Martin P, Wishart J, Thomsen MG (2016). Methods Used for Malting Small Grain Quantities. Project Report. Northern Periphery and Arctic Programme: Northern Cereals – New Markets for a Changing Environment. CAV Diary Number 304-8673-2014.

Martin P, Wishart J, Yeluripati J, Matthews R (2016). Report for Scottish Water on the Potential of Short Rotation Coppice (SRC) Willow for Water Treatment in Orkney. Orkney College UHI.

McDougall GJ, Austin C, Van Schayk E, Martin P (2016). Salal (*Gaultheria shallon*) and aronia (*Aronia melanocarpa*) fruits from Orkney: Phenolic content, composition and effect of wine-making. *Food Chemistry* 205: 239-247.

10 Contacts

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