University of the Highlands and Islands Orkney College

AGRONOMY INSTITUTE

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- For Northern Temperate Crop Research -

ANNUAL REPORT

(April 2013 to March 2014)

Planting a short rotation forestry trial at Muddisdale in April 2013

Agronomy Institute,
Orkney College UHI,
Kirkwall,
Orkney,
KW15 1LX.

www.agronomy.uhi.ac.uk

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

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1 Introduction

The Agronomy Institute (AI) is a 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 2013 to March 2014. During this period, AI research activities were concentrated on a Scottish Government funded project investigating the potential benefits of barley and oats for human health in collaboration with the Rowett Institute of Nutrition and Health and on the development and implementation of cereal projects funded by Nordic Atlantic Cooperation (NORA) and the Northern Peripheries Programme in partnership with researchers from other north European countries. Over the year, links have been strengthened with the James Hutton Institute (JHI) in cereal, legume and berry crop research and collaborations continued with Forestry Commission Scotland on short rotation forestry and with Rothamsted Research and Imperial College on willow. On the commercial side, the AI continued to manage barley supply chains for Bruichladdich and Highland Park distilleries, producing grain for the production of specialist whiskies. Locally grown flowers and berries have also been supplied to Orkney Wine Company for making into fruit wines and a new collaboration started with the Highland Brewing Company. As a prominent research centre in UHI, the Institute was part of a UHI submission to the 2014 Research Excellence Framework (REF).

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 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 Practice Guidelines and supply chains for crops and plants.
- Stimulating the market for crops and plants by collaborating with end-users to develop new products.

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 the following:

- *Research Organisations:* Agricultural Centre (Faroe Islands), Agricultural University of Iceland, Bioforsk Nord (Norway), Forestry and Agrifoods Agency (Newfoundland & Labrador, Canada), Forestry Commission Scotland, Imperial College London, Institute of Biological, Environmental and Rural Science (Aberystwyth University), MATIS (Icelandic Food and Biotech R&D), Rothamsted Research, Rowett Institute of Nutrition and Health, Science and Advice for Scottish Agriculture (SASA), The James Hutton Institute.

Sarah Mackie and Laura Mitchell (centre) of BBC Scotland's Landward team with John Wishart (left) and Peter Martin (right) of the Agronomy Institute.

- *Commercial Companies:* Bruichladdich Distillery, Highland Brewing Company, Highland Park Distillery, Isle of Arran Distillers, Lantmännen SW Seed, McCreath, Simpson & Prentice Ltd., Orkney Wine Co., PT HM Philip Morris Indonesia, Valhalla Brewery, William Shearer (Seed Merchant).

- *Growers, Growers' Groups and Trusts:* Birsay Heritage Trust, Mains of Loirston Charitable Trust, Orkney Bere supply chain, Orkney 'Tartan' supply chain, Orkney Woodland Group, SAC Consulting, Shetland Livestock Marketing Group.

The AI was involved in several knowledge transfer events including presentations on cereals at the Sanday Soulka and natural products at the the Natural Products Scotland 2013 Conference and an open event at the Institute's short rotation forestry trial in Kirkwall. AI activities have also been covered by the local press and radio. Some of the Institute's activities with Bere featured on the 2013 Christmas edition of BBC Scotland's Landward television programme.

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 the AI has developed as well as its knowledge transfer activities, particularly with cereals. In 2013, for the seventh successive year, Orkney growers planted about 20 ha of Bere for a specialist whisky market which the AI has helped to develop. Another group of five Orkney growers grew about 10 ha of modern malting barley for the fourth year to supply Highland Park Distillery with local malting barley. On-going research with early-maturing north European varieties of oats and barley in collaboration with the Orkney seed merchant, William Shearer, has identified several with considerable potential for the north of Scotland and some of these are now being grown by

John Wishart of the Agronomy Institute receiving a quaich from Highland Park Distillery Manager, Graham Manson, in recognition of the quality of malting barley produced by the Institute in 2013.

farmers in Orkney and Shetland. Further work in Shetland, in collaboration with Shetland Livestock Marketing Group, and other stakeholders has started in 2014.

- Commercial companies are also benefiting as crops are being made available for the development of new products. Thus, new Bere whiskies, produced as a result of AI collaboration, were released by both Isle of Arran Distillers and Bruichladdich Distillery in 2012 and Shetland's Valhalla Brewery continues to produce a beer made from Orkney Bere. 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 resulted in the release of an all-Orkney white wine in December 2012 and further new wines are planned for 2014. A new project using locally grown cereals for beer started in 2014 with the Highland Brewing Company. Straw, from north European varieties of oats, is being used for making exclusive Orkney straw-back chairs.

Tartan malting barley being grown for Highland Park Distillery at Orkney College with Highland Park Distillery Manager, Graham Manson (left), Edrington Group Technical Support Manager, Alexander Tweedie (centre), and McCreath, Simpson & Prentice Ltd Director of Cereal Seeds, Paul Huntley (right).

- As a research centre within UHI, it is particularly important 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) Inverness-shire (Agros Associates and Essentially Scottish Botanicals Ltd), Islay (Bruichladdich Distillery), Arran (Isle of Arran Distillers) and Perthshire (Blair Atholl Watermill) demonstrate that the Institute's activities impact on many parts of the region.

- 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 Peripheries 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 Bere, willow and sweet gale 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 plant research themes are listed below:

Rob Hill, Head Brewer and owner of the Highland Brewing Company, sampling a porter beer maturing in ex-Bere whisky casks supplied by the Agronomy Institute in 2012.

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 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 particularly suitable for the north of Scotland and both Finnish and Swedish 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 also included the ancient Scottish barley landrace, Bere, which is also very early maturing.

5.2 Biomass Crops

These are being investigated as a possible source of local renewable heating fuel to help reduce dependence on fossil fuels and hence reduce greenhouse gas emissions which are associated with climate change. The initial emphasis of AI research into biomass crops was on investigating the potential for using willow (*Salix* spp) grown as short rotation coppice (SRC). The first willow trial was planted in 2002, followed by larger trials in 2006 and 2007.

Harvesting the Agronomy Institute willow trial at Muddisdale with a cut-and-chip harvester (JF 192 Z10).

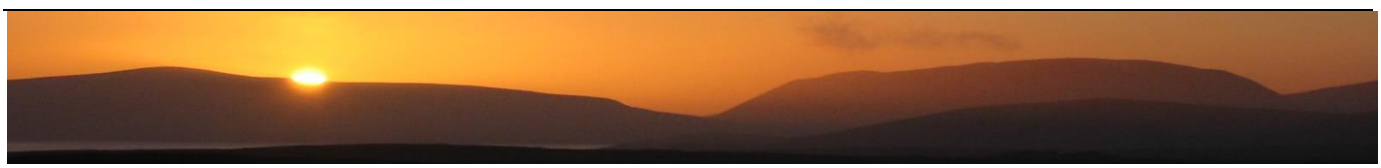
Since 2011, the AI has been collaborating with Forestry Commission Scotland and Orkney Woodland Group to investigate the potential for short rotation forestry (SRF) in Orkney. For SRF, trees are planted at a closer spacing (c. 2,000-3,000 trees/ha) than for normal forestry, but not as close as for SRC. Fast growing tree species are used, with the objective of harvesting them at about 15-20 years. Several of the species used can be coppiced and should therefore regenerate after harvesting. SRF systems are considered to be particularly suitable for the establishment of small areas of woodland on farms where the wood could have a number of end-uses, including firewood. The attraction of SRF in Orkney is that land owners are often interested in planting small areas of woodland, usually for non-commercial reasons, and are already using a close spacing as this provides trees with mutual protection from the wind. Close planting, however, eventually results in a need for thinning or coppicing and this could provide an opportunity for growers to use or sell the harvested wood for firewood. The market for this has expanded considerably in Orkney, in recent years. A major advantage of SRF for small-scale growers in remote areas is that harvesting and processing into a utilisable fuel (split logs) can be achieved without the need for 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 those investigated in recent projects have been grown for the pharmaceutical and cosmetic market or for flavourings. The AI ran a major project on sweet gale (*Myrica gale*), the source of a high-value cosmetic oil, for The Boots Company Plc from 2008 to 2011. Other research has included a trial with Alzeim Ltd on *Narcissus* cultivars as a source of galanthamine for treating Alzheimer's disease. A recent study of the flora of the Highlands and Islands and traditional plant use in the area for Agros Associates has identified a number of native plants with potential for commercialisation.

Sea buckthorn fruiting at Orkney College. In 2013, a good crop of berries was produced by several trees in the Institute's seabuckthorn collection.

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*), black chokeberry (*Aronia melanocarpa*), Saskatoon (*Amelanchier alnifolia*), low-bush blueberries (*Vaccinium angustifolium*) and elder (*Sambucus nigra*).



6 Funded Projects And Commercial Activities

Income from research projects and commercial activities are vital for ensuring the financial sustainability of the AI. In 2013 the AI was involved in the following projects and commercial activities:

6.1 Cereals

RESAS Food And Drink Strategic Partnership

This project involves collaboration between some of the main research providers to the Scottish Government (The James Hutton Institute and Rowett Institute of Nutrition and Health) and several Higher Education Institutes (UHI and the Universities of Aberdeen and Dundee) into the health benefits of oats and barley. A high consumption of whole-grain foods is associated with a lower risk of coronary heart disease, hypertension and type 2 diabetes. One of the most important factors determining the health benefits of whole grain foods is thought to be their β-glucan content and the ratio between high and low molecular weight fractions. Low molecular weight β-glucans may have a particularly beneficial effect because they are highly fermentable in the gut and have toxin binding activity. The project is looking at the range of factors which can influence cereal β-glucan content – from genes to varieties, growing conditions and grain processing – as well as investigating effects of specific cereal products and different β-glucan fractions on gut microbiota and health parameters.

Plots of barley (top, left) and oats (top, right) growing at Orkney College as part of the RESAS food and drink strategic partnership.

The AI is supporting the partnership by providing it with a north of Scotland research and trials facility and in 2012 and 2013 established trials with different varieties of oats and barley, including traditional landraces and Swedish varieties, to compare their growth and grain β-glucan content. Since some of these varieties will also be grown in trials in more southerly areas, the AI trials will also allow the effect of Orkney's more northern growing conditions on growth and grain β-glucan content to be investigated. Seeds of Swedish cereal varieties were provided by Lantmännen SW Seed.

Northern Cereals – New Opportunities

This is a collaborative project between the AI and partners in Iceland (MATIS and Agricultural University of Iceland), northern Norway (Bioforsk Nord), Faroes (Agricultural Centre) and Newfoundland & Labrador (Forestry and Agrifoods Agency). The project has 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, a revival of interest in "local" production and probably also by changes in climate. The aim of the project is to encourage cereal production in the partner regions in order to promote greater self-reliance and to facilitate the development of new markets (to be addressed by a separate project described in the next section). Funding for several of the project partners is provided by Nordic Atlantic Cooperation (NORA).Within the project the AI will be carrying out cereal-related activities in both Orkney and Shetland. The work in Shetland is in collaboration with Shetland Livestock Marketing Group and local stakeholders and is being supported by a grant from the Mains of Loirston Charitable Trust.

Black oats (*Avena strigosa*), one of several traditional cereal varieties grown at Orkney College as part of the RESAS project.

Cereal Products In The North

This project includes most of the partners participating in the previous project and is a preparatory project funded by the Northern Peripheries Programme (NPP). The aim of the preparatory project is to develop a main project which will help to develop new food and drink products utilising locally grown cereals in the partner regions, thereby fostering the development of higher value markets for local cereals. New product development in these areas is particularly appropriate at the moment because of the large numbers of tourists visiting the partner areas and the demand by these visitors for local food and drink products.

Planting Bere at Orkney College in 2013 for supply to Bruichladdich Distillery for specialist whisky production.

Developing An Orkney Beer From Locally Grown Bere

Bere is well-suited to growing in Orkney for dried grain because it is very early maturing. Compared with modern malting varieties, however, it is not ideal for malting because of its high grain protein content which results in lower alcohol yields. Bere malt has other interesting characteristics, however, which could be advantageous to end-users. The AI and Orkney's Highland Brewing Company have been awarded Interface funding in 2014 for a project which will seek to use these characteristics to develop a new beer using Orkney-grown Bere.

In a separate collaboration, the Highland Brewing Company has been using some of the casks released after the bottling of Isle of Arran Distillers' Bere whisky in 2012 to mature some of its beer. This will be released as a porter in 2014.

Oat Straw For Orkney Chairs

Orkney straw-back chairs are a traditional, but exclusive, craft product which are made locally by both professional and part-time craftsmen. Although the market was established by David Kirkness in the late 1800s and early 1900's, there is still a strong demand for them and they provide a good example of a local agricultural crop (oat straw) being used to produce a high value, regionally distinct product. It is thought that around 300 chairs are produced annually in Orkney and they are now exported to many parts of the world. The best oat straw for chair backs needs to combine length with both bulk and suppleness. As a result of oat variety trials within the RESAS project, it has been possible to provide a local maker of Orkney chairs, Fraser Anderson, with straw from different varieties which he has tested for making into chair backs. So far, he has identified at least two varieties which are well-suited for this purpose. Local oat straw is also used for basketry and hobby work.

Traditional Orkney straw-backed chairs made by Fraser Anderson using straw from north European oat varieties grown in trials at Orkney College during 2013.

Supply Chain For Bere Whisky (Bruichladdich Distillery)

For the seventh year, the AI managed a supply chain which produced almost 50 t of Orkney-grown Bere for Bruichladdich distillery which will be used for the production of specialist Bere whiskies. The distillery released its first Bere whisky in 2012, which was produced as a result of collaboration between the Institute and Dunlossit Estate on Islay.

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

As a result of a malting barley variety trial run by the AI in 2009 and micromalting tests on grain samples, Highland Park selected the variety 'Tartan' as being particularly well-suited to Orkney and asked the AI to develop a local supply chain for growing the variety. Since 2010, five local farms have each been growing about 2 ha of 'Tartan' and about 50 t of grain have been delivered to the distillery each year. The grain is malted and distilled at the distillery and the spirit put into casks and stored on site. The aim, after several years of maturation, is to produce a specialist "all-Orkney" whisky. With seed of 'Tartan' no longer commercially available, the AI is also assisting each farmer to keep his own line of 'farm-saved seed' which is sent down to McCreath, Simpson & Prentice Ltd. for dressing and safe storage. The Orkney supply chain produces the UK's most northerly malting barley and, to meet the challenges that this poses, the distillery funds the AI to carry out research for the supply chain aimed at ensuring high quality.

John Wishart processing willow samples from the Muddisdale willow trial before sending to Imperial College for analysis.

6.2 Biomass

Short Rotation Coppice (SRC)

The AI's willow trials were established to assess the crop as a potential source of a local biomass heating fuel, but recent research linkages have resulted in these trials contributing to a UK-wide research effort into developing the crop as a source of biofuels. Although willow can produce large quantities of biomass, the potential for using it for biofuel production is limited by the amount of easily accessible carbon which is available. This is one of the principal issues being addressed by the BBSRC Sustainable Energy Centre for Biomass (BSBEC-Biomass), the UK's main research hub for developing biomass crops for bioenergy and biofuels. Since 2011, the AI has been collaborating with BSBEC-Biomass researchers at Rothamsted Research and Imperial College London and one of the outcomes has been the identification of genetic and environmental effects which could greatly increase the potential for using willow wood as a source of biofuels. It is currently thought that Orkney's windy climate causes changes in willow wood structure (the formation of "reaction wood") which can result in the stems of some clones having very much higher amounts of readily available sugars than others. The Orkney trials were harvested in 2013 to allow sampling of re-growth from a range of clones at the end of the year.

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 managed by the Institute (at Muddisdale) and the other by Balfour Mains on the island of Shapinsay. Both trials contain the same nine species (sycamore, *Acer pseudoplatanus*; Italian alder, *Alnus cordata*; common alder, *Alnus glutinosa*; beech, *Fagus sylvatica*; aspen, *Populus tremula*; goat willow, *Salix caprea*; mountain ash, *Sorbus aucuparia*; whitebeam, *Sorbus intermedia*) and have a similar experimental design. Survival at the end of the first year was very good at both sites and most growth was made by goat willow, common alder, aspen and Italian alder. Future monitoring of the trials will continue in collaboration with FCS and this will provide comparative data on the growth of the different tree species under Northern Isles conditions, complementing other trials established by the Forestry Commission on mainland Scotland (http://www.forestry.gov.uk/forestry/INFD-85UFMB).

Open event in December 2013 at the Agronomy Institute short rotation forestry trial at Muddisdale.

6.3 Natural Products

Northern Berries For Orkney Wine

Orkney Wine Company (OWC) produces a range of fruit wines and liqueurs using non-grape ingredients. In 2012, collaboration between OWC and the AI investigated the potential for including some of the northern fruit species which are grown by the Institute in OWC's wines. The aim of this was to help the company produce unusual wines with a high proportion of local ingredients. The collaboration has been assisted by chemical analyses of the berries and wines carried out by the James Hutton Institute. The first product from this collaboration, 'Orkney White', a white wine including elder flowers from the AI's elder collection was released in December 2012. This collaboration continued in 2013 and further new wines are anticipated in 2014. Another area of collaboration between OWC and the AI has been the use of ex-Bere whisky casks, supplied by the AI, for maturing some of OWC's wines and producing liqueurs.

Liqueurs (front row) produced by the Orkney Wine Company and matured in ex-Bere whisky casks supplied by the Agronomy Institute.

7 Staff

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

Dr Peter Martin - Director
Mr John Wishart – Field, laboratory and technical support
Mr Billy Scott – Additional support

8 Publications

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

Martin, P. (2013). Report to Forestry Commission Scotland on Phase Two of a Project to Establish Short Rotation Forestry Trials In Orkney. Orkney College UHI.

Martin, P. (2013). Report to Orkney Wine Company on a feasibilty project into the use of locally grown northern fruits for wine making. Orkney College UHI.

Martin, P. (2014). Report to Highland Park Distillery on the performance of an Orkney supply chain for malting barley in 2013. Orkney College UHI.

Martin, P., Wishart, J., Scott, B. (2013). Orkney Bere whisky – a single malt from a Scottish landrace. *Landraces 2, 16-18.*

9 Contacts

For further information about the Agronomy Institute, contact:

Dr Peter Martin (Director)

Agronomy Institute,
Orkney College UHI,
Kirkwall,
Orkney,
KW15 1LX,
Scotland.

Tel: +44 (0)1856 569298
Fax: +44 (0)1856 569001

Email: peter.martin@uhi.ac.uk

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