

AGRONOMY INSTITUTE

- For Northern Temperate Crop Research -

2-YEAR REPORT (April 2010 to March 2012)



The Swedish wheat variety Demonstrant being grown at Pitlochry for Blair Atholl Water Mill

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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 two years from April 2010 to March 2012. During this period, considerable AI resources were focused on research projects investigating the agronomy of sweet gale (*Myrica gale*), the potential for growing crops as a source of pelleted fuel (PELLETime project), developing markets for northern cereal varieties and promoting amenity plants through a Northern Periphery Programme (NPP) project (New Plants for Northern Periphery Market). In addition, several new projects were started with commercial partners aimed at developing local sources of cereals for both milling and malting, and at identifying Scottish plants for natural products. Important research linkages were also developed by AI involvement in a Scottish Government funded food and drink strategic partnership to investigate the potential benefits of barley and oats on human health and in the Scottish Universities Industry Innovation Network for Food and Drink. In collaboration with the Forestry Commission, research was also started on short rotation forestry in Orkney, supplementing the AI's research programme on short rotation coppice willows. On the commercial side, the AI continued to manage an Orkney supply chain producing Bere barley for Bruichladdich distillery and established a separate supply chain producing a modern malting barley variety for Orkney's Highland Park distillery. The period saw the successful completion of postgraduate research programmes by three students conducting research on arnica, willow and Bere.

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 & Islands (H&I), 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 research programme is 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 and individuals is very important and over the period the AI actively engaged with the following:

- *Research Organisations and Local Authorities:* Agricultural University of Iceland, Agri-Food and Biosciences Institute, Forestry Commission, Institute of Biological, Environmental and Rural Science (Aberystwyth University), Inverness College, MTT Agri-Food Research, National Non-Food Crops Centre, North Karelia University of Applied Sciences, Orkney Island Council, Oulu University of Applied Sciences, Piteå Municipality, Rothamsted Research, Rowett Institute of Nutrition and Health, Scottish Agricultural College (SAC), Science and Advice for Scottish Agriculture (SASA), Scottish Agricultural Organisation Society Ltd (SAOS), Shetland Island Council, Swedish University of Agricultural Sciences, The James Hutton Institute, University of Aberdeen, University of Kuopio.
- *Commercial Companies:* Agros Associates, Alzeim Ltd., Argo's Bakery, Birsay Bay Tearoom, Blair Atholl Watermill, Bruichladdich Distillery, COPE Ltd, Donaldsons of Orkney, ER & T Craigie, Essentially Scottish Botanicals Ltd, Highland Birchwoods, Highland Park Distillery, Isle of Arran Distillers, Isle of Barra Distillery, Isle of Skye Brewery, JF Groundwater Baker and Greengrocer, JLB Design Ltd., Lantmännen SW Seed, Orkney Wine Co., Shetland Heat Energy and Power Ltd, Technology Crops International Ltd, The Boots Company Plc, The Foveran Hotel and Restaurant, Valhalla Brewery, William Shearer (Seed Merchant).
- *Growers, Growers' Groups and Trusts:* Birsay Trust, Orkney growers of Bere for Bruichladdich and Tartan for Highland Park, Orkney Renewable Energy Forum (OREF), Orkney and Shetland PELLETime project stakeholder groups, Orkney Great Yellow Bumblebee Group, Orkney Woodland Group, Shetland Amenity Trust.

The AI held well attended open days at the College in July 2010 and 2011 and received a number of other visitors and groups including international collaborators in the New Plants for the Northern Periphery Market project, Orkney members of NFU Scotland and Scottish branch members of the Institute of Horticulture. In addition, AI staff also made presentations to the AAB Conference On Non-Food Uses of Crops, the 7th Circumpolar Agricultural Conference, Conference On Garden Plants For Northern & Maritime Regions (Iceland), the Orkney International Science Festival and to the Orkney Agricultural Discussion Society. AI research activities have been covered by the local press, radio and BBC Two Landward.



Meeting at Highland Park distillery between growers and staff from the AI and The Edrington Group to discuss results of supply chain operations in 2010.

4 Impact Of The Agronomy Institute

The AI has continued to make an impact at several levels:

- Growers and stakeholder groups have benefited from the AI's knowledge transfer activities, particularly with cereal and biomass crops. In 2011, for the fifth successive year, Orkney growers planted about 20 ha of Bere



for a specialist whisky market which the AI has helped to develop. In parallel, another group of Orkney growers grew about 10 ha of modern malting barley for Highland Park Distillery in both 2010 and 2011. As a result of AI activities with Bere, it was added to the UK National List as a conservation variety in 2010. There has also been considerable interest from local farmers in early-maturing north European varieties of barley, oats and wheat, which the AI tested in 2010 in collaboration with the Orkney seed merchant, William Shearer. As a result, a significant number ordered their own seed to test these varieties themselves in 2011. In 2011, a Pitlochry farmer was helped by the AI to investigate the feasibility of growing wheat for a local water mill at Blair Atholl. With funding from the NPP Pelletime Project, the AI was able to commission the construction of a small scale willow harvester which should help willow growers in Orkney to harvest this crop. More general benefits result from AI interactions with organisations like the Orkney Agricultural Discussion Society, NFUS, AI open days and contributions to the farming press and media.



Rami Cohen (left) from Blair Atholl Watermill and Bill King, a Pitlochry farmer, at the top of a trial plot of a Swedish variety of wheat.

- Commercial companies, particularly in the Highlands and Islands, are also benefiting as crops are being made available for the development of new products. In both 2010 and 2011, a supply chain developed and managed by the AI produced over 50 t of local malting barley which will be used by Highland Park Distillery to produce a niche market all-Orkney whisky. This complements a separate Orkney supply chain managed by the AI which produces grain of Bere, a very old Scottish barley landrace, for Bruichladdich Distillery. AI expertise in developing small scale malting barley supply chains has also benefitted the Isle of Barra distillery which the AI has assisted concerning the identification of options for sourcing its malt. AI research on north European cereal varieties has helped the Orkney seed merchant, William Shearer, to develop new seed markets in the north of Scotland. Through AI research on milling varieties of wheat and oats, Orkney's Barony Mill has been able to diversify its flour production while local bakery companies and the hospitality sector have benefited from the availability of local flours for specialist bakery products. Another water mill, in Blair Atholl, has been assisted by the AI to investigate the possibility of sourcing its wheat locally rather than from the north of England. Collaborative work on developing sweet gale (*Myrica gale*) as an agricultural crop has also benefited Essentially Scottish Botanicals Ltd and The Boots Company Plc.
- As a research centre within UHI, it is particularly important that the activities of the AI are spread over the Highlands and Islands. In addition to the AI's strong Orkney links, it is clear from its collaboration with organisations like Agros Associates (Inverness-shire), Bruichladdich Distillery (Islay), Blair Atholl Watermill (Perthshire), Essentially Scottish Botanicals Ltd (Inverness-shire) and from its contribution to sweet gale research (6 trials sites on mainland Scotland) and the PELLETIME project (one trial in Shetland and one in Orkney) that the Institute's activities impact on many parts of the region.
- The AI makes a valuable contribution to the research capacity of UHI and the Institute was one of eight submissions from UHI to the 2008 Research Assessment Exercise (RAE).
- Through its collaboration in NPP projects (PELLETIME and New Plants for the Northern Periphery Market) and through links with organisations like the Circumpolar Agriculture Association, the AI is also positioning itself amongst research and development organisations in northern Europe.

5 Plant Research Themes

As a result of reviews of the market for novel crops in the H&I, 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:



5.1 Early Maturing Cereal Varieties

Under this theme, the Institute is investigating both modern and heritage cereal varieties which are suited to the H&I's northern environment. They are mainly being considered for bakery and drinks products and include varieties of barley, wheat and oats. Northern varieties from Scandinavia are thought to be particularly suitable for the north of Scotland because they include a number of short-season varieties which come to maturity earlier than most UK varieties. Consequently, Finnish and Swedish varieties of wheat and oats have been grown successfully in Orkney for several years. The AI has also tested several UK varieties of malting barley and identified a few which are earlier than others and these also have potential for the H&I area. AI research and commercialisation activities have also included the ancient Scottish barley landrace, bere, which is another very early maturing variety. Bere was the subject of a postgraduate research programme undertaken by Syed Shah from 2007.



Malting barley variety trial established in 2011 for Highland Park distillery to identify early-maturing varieties suitable for use in Orkney.

5.2 Biomass Crops

These are being investigated as a possible local renewable heating fuel to help reduce dependence on fossil fuels and hence reduce greenhouse gas emissions which are associated with climate change. The main emphasis of AI research into biomass crops has focused on the potential for using willow (*Salix* spp) grown as short rotation coppice (SRC). The AI's first willow trial was planted in 2002 and larger trials were established in 2006 and 2007. Monitoring of these trials was an important part of a postgraduate research programme undertaken by Fay M^oKenzie. Since 2011, the AI has been collaborating with the Forestry Commission and Orkney Woodland Group to investigate the potential for short rotation forestry (SRF) in Orkney.

As part of a 3-year Northern Peripheries Programme project (PELLETime, see Section 6) investigating the potential of several crops as a source of material for producing pelleted fuel, the AI also started a trial on reed canary grass (*Phalaris arundinacea*).

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. The AI ran a major project on sweet gale (*Myrica gale*), the source of a high-value pharmaceutical oil (see Section 6), 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.

Research on the medicinal plant arnica (*Arnica montana* and *Arnica chamissonis*) formed the basis of postgraduate studies undertaken by Elizabeth Barron.

A number of 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. Several species are being grown by the AI, including cranberry (*Vaccinium macrocarpon*), sea buckthorn (*Hippophae rhamnoides*) and black chokeberry, (*Aronia melanocarpa*).

6 Funded Projects And Commercial Activities

Income from research projects and commercial activities is vital for ensuring the financial sustainability of the AI. Between 2010 and 2012, AI staff were 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 will seek to look 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.



A green plot of the UK oat variety Firth flanked by plots of two earlier maturing North European oat varieties in August 2010.

The AI is supporting the project by providing it with a north of Scotland research and trials facility. The AI will establish trials with different varieties of oats and barley, including traditional local landraces, to compare the growth and grain β -glucan content of the different varieties. 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.



Chorizo sausage containing Orkney oatmeal, developed by Donaldson's of Orkney within the Orkney Flours Project.

Identification Of North European Cereal Varieties For The North Of Scotland

In 2010, in collaboration with the Orkney seed merchant William Shearer and the Swedish seed company Lantmännen SW Seed, the AI planted variety trials comparing north European varieties of wheat, barley and oats with standard UK varieties. As a result of the trial, one promising north European early-maturing variety of each type of cereal was identified and these were planted more widely by a number of Orkney growers in 2011.

Orkney Flours Project (www.orkneyflours.co.uk)

Following a study of the local market for Orkney flours produced by Barony Mill, funding for a follow-on project was obtained by UHI from the Scottish Executive's Food Processing And Marketing Co-operation Grant Scheme. The aim of the project is to develop the market for local flours and the AI has been contracted to implement the project for UHI. The project includes Barony Mill, Orkney College Hospitality Department and several local food producers (Argos Bakery, Birsay Bay Tearoom, ER & T Craigie, Donaldsons of Orkney and the Foveran Hotel). Within the project, flours from locally grown varieties of wheat and oats have been tested in a range of food products. By combining these results with data on field performance, the best varieties for Orkney will be identified. The flours will be promoted by producing posters, leaflets, hosting a web site and holding a food event.

Blair Atholl Watermill Wheat Project

This project started in 2011 and is a feasibility study investigating the potential for the mill to source its own wheat from a local Pitlochry farmer rather than importing it from England. The project included field testing of a north European variety of wheat near Blair Atholl and use of the grain by the mill for test milling and baking in its own tea room. The project was featured in BBC Two's Landward programme in September 2011.



Supply Chain For Bere Whisky

In both 2010 and 2011, the AI managed a supply chain which produced about 60 t of Orkney-grown Bere for Bruichladdich distillery in each year. The 2011 crop was the fifth supplied to Bruichladdich for this purpose.

Supply Chain For An All-Orkney Whisky

As a result of a malting barley variety trial run by the AI in 2009 and micromalting tests on grain samples, the variety 'Tartan' was selected by Highland Park as being particularly well-suited to Orkney and the AI was asked to develop a supply chain with local growers. Five local growers each grew about 2 ha of Tartan in 2010 and 2011 and over 50 t of grain was delivered to the distillery in each year. The 2010 crop was distilled in 2011 and is believed to be the first Orkney grown barley distilled at Highland Park since 1942. Assistance for setting up the supply chain was provided by the Scottish Agricultural Organisation Society Ltd (SAOS) in 2010. Further research on varieties was carried out for Highland Park in 2011.



New make spirit from Orkney-grown Tartan malting barley coming off the still at Highland Park Distillery in August 2010.

Malt Sourcing Strategies For The Isle of Barra Distillery

The Isle of Barra Distillery (IOBD) is at an advanced stage of planning and will be a new distillery in the Western Isles of Scotland. The distillery aims to be one of the most environmentally friendly in Scotland and is keen to use locally grown barley for producing its malt. Using experience gained from establishing barley supply chains in Orkney, the AI was involved in a feasibility study for IOBD in 2011 investigating the potential for it to use locally grown barley to produce its malt.

6.2 Biomass

PELLETime Project

The PELLETime project (www.pelletime.fi) was a three-year (2008-2010) Northern Periphery Programme (NPP) project involving Scotland, Finland, Sweden and Iceland which aimed to address shortfalls in pellet production by expanding the raw material supply and increasing productive capacity by encouraging SME participation in this market. The AI conducted growing trials for the project in both Orkney and Shetland which investigated the potential of several on-farm sources of biomass for producing pelleted fuel. These included reed canary grass (*Phalaris arundinaceae*), a forage grass mix (60% perennial ryegrass (*Lolium perenne*) and 40% timothy (*Phleum pratense*)), barley (as a source of straw) and willow. The programme also includes a wide range of related topics including an environmental impact assessment of the crops, economic analysis of them, knowledge transfer activities and small scale pelleting trials. A legacy from the project was the development of a small-scale whole-rod willow harvester which was developed for the AI by JLB Design Ltd.



Prototype small-scale whole-rod willow harvester being tested on 3-year-old willow at Muddisdale.



6.3 Natural Products

Sweet Gale Research Project

This project ran for 3 ½ years until May 2011 and was implemented for The Boots Company Plc by the AI. Sweet gale, or bog myrtle (*Myrica gale*), is a shrub which is native to the UK and is particularly common in high rainfall areas like north-west and north Scotland where it can be found from sea-level up to about 500 m. It has a tradition of use in many countries but has recently attracted attention as the source of an oil (obtained from the leaves) which is being used for cosmetic products by Boots. In the past, sweet gale oil has been obtained by harvesting leaf from wild stands, but to increase production to meet growing demand for the oil, interest is focusing on developing sweet gale as an agricultural crop. Since very little is known about the growth of sweet gale under cultivated conditions, this project was developed to investigate the crop and develop recommendations for growing it.



Sweet gale trial plot being harvested at SAC Craibstone in 2010 when plants were in their third season of growth.

As a first step in providing information about the growth and oil yield from newly planted sweet gale, trials containing about 1,000 plants were established at seven different locations in the H&I during 2008. These were monitored over the 3 years of the project to provide basic information on site-to-site variation in growth, leaf yield and leaf oil content. Soil and weather data were also collected from these sites to see whether plant growth and leaf and oil production can be related to these environmental factors. Other topics investigated within the project were the use of different types of planting material, management of plants in their early years, the effect of fertiliser on leaf and oil yields, the development of weed control strategies and the incidence of pests and diseases.

Traditional Plant Use

In 2010, The AI carried out a study for Agros Associates to identify potentially commercialisable plants in the Highlands and Islands which have a tradition of use for food and drink, cosmetic and medicinal purposes. The study identified about 30 species with potential which, on further screening, were reduced to a short-list of 22 species. A partnership between Agros Associates and several UHI research centres has been formed to further develop the commercialisation of some of these plants.

6.4 Amenity Horticulture

New Plants For The Northern Periphery (NPNP)

This project (<http://www.northernplants.net/>) is funded by the Northern Peripheries Programme and includes partners in Sweden, Finland and Iceland as well as the AI. The aim of the project is to develop new business opportunities within the region's horticultural sector by identifying and promoting new hardy ornamental plants for public spaces and private gardens. Within the project, each partner has selected a number of hardy ornamental plants which grow well in their own region. Based on a questionnaire sent out to stakeholders and discussions with specialists, each partner has selected a number of plants for testing from the other partners. These plants will be established in demonstration areas / gardens in all the partner countries where they will be shown to the public through open events. Links with the commercial sector, which will be built up during the project, will then be used to market the best of these plants. Plants being grown by the AI will be tested in Shetland by COPE as well as in Orkney. Project partners met in Orkney in September 2010 and plant exchanges between the partners started in 2011.



Partners from the New Plants for the Northern Periphery project visiting Nathagi nursery in Iceland. The nursery produced some of the plants being tested within the project.



7 Postgraduate Research And Training Programmes

Over the period of this report, 3 postgraduate students completed their studies and were successfully examined:

- Elizabeth Barron was awarded a PhD for her research on *Arnica montana*
- Fay M^cKenzie was awarded an MSc by research for her work on biomass willows
- Syed Shah was awarded a PhD for his research on bere barley

The AI also provides opportunities for students to carry out projects and structured work programmes. In 2010, it hosted Amélie Viard and Alexis Busserolle of the Agronomy Campus at Clermont in France and in 2011 provided research facilities for Alice Tait to carry out a Science baccalaureate project on wheat.

8 Staff

The following staff worked at the AI over the period:

Dr Xianmin Chang – Researcher (until June 2011)
Dr Peter Martin - Director
Mr Billy Scott - Field Trials Officer
Dr Geoffrey Sellers - Research Fellow (until June 2011)
Mr John Wishart - Technician.

9 Publications

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

- Barron, E. (2010).** Quantitative analysis of active compounds found in *Arnica montana* and *Arnica chamissonis* in relation to varied provenance, environmental and agronomic factors. PhD thesis. University of Aberdeen.
- Martin, P. (2010).** North European Cereals For The North Of Scotland. *The Crofter* 88, p. 15.
- Martin, P. (2010).** North European Cereal Varieties For The North Of Scotland. *The Crofter* 89, p.7.
- Martin, P. (2011).** Report to Uisge Beatha Nan Eilean (Isle of Barra Distillery) on options for sourcing local barley for malt.
- Martin, P. (2011).** Final report to Blair Atholl Watermill on a project to determine the feasibility of local sourcing of milling wheat
- Martin, P. (2012).** Report to Highland Park Distillery on results from a malting barley variety trial in 2011
- Martin, P. (2012).** Report to Highland Park Distillery on the performance of an Orkney supply chain for malting barley in 2011
- Martin, P. and Chang, X (2010).** Report to William Shearer (Agricultural Seeds & General Merchants) on research and development activities with North European cereal varieties.
- Martin, P. and Chang, X (2010).** Report to Highland Park on the performance of an Orkney supply chain for malting barley in 2010.
- Martin, P. and Chang, X (2011).** Highlands & Islands plant species traditionally used for food, drink, cosmetic and medicinal uses with potential for commercialisation. Report to Agros Associates.
- Martin, P. and Chang, X (2011).** Report on results from Agronomy Institute research on sweet gale 2008-2011. Report to The Boots Company PLC.
- Martin, P., Chang, X. and Wishart, J. (2010).** Yield response of Bere, a Scottish barley landrace, to cultural practices and agricultural inputs. *Journal of Agriculture and Environment for International Development* 104 (1-2): 39-60.
- M^cKenzie, F. (2011).** The potential of short rotation coppice (SRC) willow (*Salix* L.) as a biomass crop in Orkney. MSc by research thesis. University of Aberdeen
- Sellers, G. and Martin, P. (2010).** Report for the Orkney and Shetland crop trials. PELLETTime Project Commissioned Report (http://www.pelletime.fi/publications/study_reports.htm).
- Shah, S. (2012).** Differential responses of a Scottish landrace of barley (Bere) to a range of agricultural inputs in Orkney. PhD thesis. University of Aberdeen.



10 Contacts

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