

AGRONOMY INSTITUTE

- For Northern Temperate Crop Research -

ANNUAL REPORT (April 2012 to March 2013)



Planting 'Tartan' malting barley in April 2012 for Highland Park's supply chain

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Contents

1	Introduction	2
2	Background	2
3	Links With Other Organisations And Profile Raising Activities	3
4	Impact Of The Agronomy Institute	3
5	Plant Research Themes.....	4
5.1	Early Maturing Cereal Varieties.....	4
5.2	Biomass Crops	5
5.3	Plants For Natural Products	5
6	Funded Projects And Commercial Activities.....	6
6.1	Cereals.....	6
6.2	Biomass.....	7
6.3	Natural Products.....	8
6.4	Amenity Horticulture	8
7	Staff	9
8	Publications	9
9	Contacts	10

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 2012 to March 2013. During this period, AI research activities were concentrated on two major Scottish Government funded projects, one investigating the potential benefits of barley and oats on human health in collaboration with the Rowett Institute of Nutrition and Health (RINH), the other promoting the market for flours milled in Orkney from locally grown cereals. In addition, a new project utilising northern berries was started with the Orkney Wine Company and this has led to further links with researchers at RINH and the James Hutton Institute (JHI). A collaboration on willow with Rothamsted Research and Imperial College has resulted in research results which will help the future utilisation of the crop as a source of wood for biofuels. 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. An important landmark was reached in 2012, with the release of two commercial Bere whiskies, both of which resulted from significant AI involvement.

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, Forestry Commission Scotland, Imperial College London, Institute of Biological, Environmental and Rural Science (Aberystwyth University), MTT Agri-Food Research, National Non-Food Crops Centre, Orkney Island Council, Oulu University of Applied Sciences, Piteå Municipality, Rothamsted Research, Rowett Institute of Nutrition and Health, Science and Advice for Scottish Agriculture (SASA), The James Hutton Institute.
- *Commercial Companies:* Argo's Bakery, Birsay Bay Tearoom, Bruichladdich Distillery, COPE Ltd, Donaldsons of Orkney, ER & T Craigie, Highland Park Distillery, Isle of Arran Distillers, Lantmännen SW Seed, McCreath, Simpson & Prentice Ltd., Orkney Wine Co., Swannay Brewery, 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 Woodland Group.



Tasting event, showcasing products made from local flours, organised by the Agronomy Institute as part of the Orkney Flours Project.

The AI hosted two well-attended knowledge transfer events at Orkney College in 2012, one in April showcasing a range of products made by Orkney companies using local flours and the other, in December, launching an Orkney Bere whisky produced in collaboration with Isle of Arran Distillers. AI cereal research and commercialisation activities were also displayed at the Orkney International Science Festival and presented at UHI's 'Mapping The Past And Charting The Future' conference. AI activities have been covered by the local and national press and radio.

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 new markets for crops and supply chains the AI has developed as well as its knowledge transfer activities, particularly with cereals. Thus, in 2012, for the sixth successive year, Orkney growers planted about 20 ha of Bere, supplied by the AI, 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 third year, to supply Highland Park Distillery with local malting barley. AI research in support of these supply chains helps growers to achieve high quality. Early recognition of the high standard of the partnership approach adopted by the Highland Park supply chain was received in 2012 when the distillery and the AI were short-listed for a Scottish Food and Drink



Marty Hay, one of the Orkney growers of Tartan, receiving a quich from Highland Park Distillery Manager, Graham Manson, in recognition of the quality of malting barley he produced in 2012.



award. 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 farmers in Orkney and Shetland.

- Commercial companies are also benefiting as crops are being made available for the development of new products. Thus, new Bere whiskies 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 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.
- 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, it is clear from recent collaboration with commercial organisations like Agros Associates (Inverness-shire), Bruichladdich Distillery (Islay), Blair Atholl Watermill (Perthshire), Essentially Scottish Botanicals Ltd (Inverness-shire), Isle of Arran Distillers (Arran) 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.
- With an aspiration for 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. 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 (see Section 8). The Institute was one of eight submissions from UHI to the 2008 Research Assessment Exercise (RAE) and is preparing to contribute to the 2014 Research Excellence Framework (REF).



Euan Mitchell (left), Managing Director of Isle of Arran Distillers and Emile Van Schayk (right), joint owner of Orkney Wine Company. Both companies have produced new products as a result of collaboration with the AI.



Bruichladdich Distillery's first release of a Bere whisky. The Bere was grown in 2006 on Dunlossit Estate (Islay) in collaboration with the Agronomy Institute.

5 Plant Research Themes

As a result of reviews of potential markets for local crops in the H&I area, 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 early maturing and therefore suited to growing in the H&I's short growing season. 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 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 H&I area. AI research



and commercialisation activities have also included the ancient Scottish barley landrace, Bere, which is another very early maturing variety.

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 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.

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 and trials are due to be established in 2013. 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 so that they should regenerate after harvesting. SRF is considered to be particularly suitable for the establishment of small areas of woodland on farms where the wood could have a range 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, SRC does not usually reach a diameter suitable for burning as logs and is normally processed into wood chips and requires access to an expensive, dedicated harvester and, depending on harvesting method, a wood chipper.



12-year-old sycamore trees at Glaitness woodland, Kirkwall planted at a close spacing similar to that used for short rotation forestry.

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 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.

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*).



Cranberries fruiting in AI trials. This is one of the northern berry species being tested by the AI in trials at Orkney College UHI.



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 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.

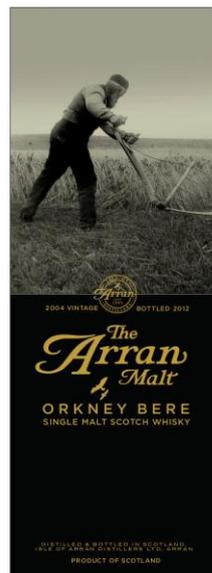


Barley variety trial at Orkney College established to support research into the health benefits of oats and barley in collaboration with the Rowett Institute of Nutrition and Health.

The AI is supporting the partnership by providing it with a north of Scotland research and trials facility and in 2012 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. Seed of Swedish cereal varieties was provided by Lantmännen SW Seed.

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 was 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 most suitable varieties for Orkney have been identified. The project included the development of posters, leaflets and a web site for promoting the flours and a food event at Orkney College and display at Orkney International Science Festival where products made from the flours were available for tasting.



Isle of Arran Distillers' Orkney Bere whisky which was produced collaboratively with the Agronomy Institute.



Isle of Arran Orkney Bere Whisky

In searching for new markets for Bere which would help with the on-farm conservation of this ancient Scottish landrace, the AI developed the concept of producing a 21st century Bere whisky. Testing the concept started in 2004 when a collaborative project was developed with Isle of Arran Distillers. Within the project, the AI provided Orkney-grown Bere which was malted at Bairds Malt in Inverness and distilled at Lochranza distillery (Isle of Arran). The new-make spirit was then put into American oak ex-Bourbon casks and stored at Lochranza. During its maturation, the spirit appears to have developed more rapidly than that from modern barley and so it was decided to release the first whisky in December 2012 as a limited edition (5,800 bottles) 8-year-old single malt. The launch event was held at Orkney College and there has been considerable interest in, and a strong demand for, the whisky.

In order to provide local companies with an opportunity for developing added-value products associated with this special whisky, empty Bere whisky casks have been supplied to both Swannay Brewery and the Orkney Wine Company.

Supply Chain For Bere Whisky (Bruichladdich Distillery)

For the sixth year, the AI managed a supply chain which produced over 50 t of Orkney-grown Bere for Bruichladdich distillery which will be used for the production of specialist Bere whiskies. In November 2012, the distillery released its first Bere whisky, a 6-year-old single malt produced from Bere grown at Dunlossit Estate on Islay. This whisky resulted from collaboration with the AI which provided the Estate with both the seed and advice for growing the crop in 2005.

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 has 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. Until the distillation of 'Tartan' in 2010, the last previous distillation of Orkney-grown barley at Highland Park is thought to have been in 1942. 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. As a result of the strong collaborative approach adopted by the supply chain, the AI and distillery were one of three finalists for a 2012 Scottish Food and Drink award in the "success through working in partnership" category.

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



Tartan grain being harvested at Orkney College in 2012 for supply to Highland Park Distillery for specialist whisky production.



Eccentric stem growth of willow ('Tora') in the AI's clone trial at Muddisdale, probably resulting from wind. This is thought to be a factor resulting in high levels of easily accessible sugars from some willow clones grown in Orkney.



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 (see Brereton *et al.* (2012) in Section 8). 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.

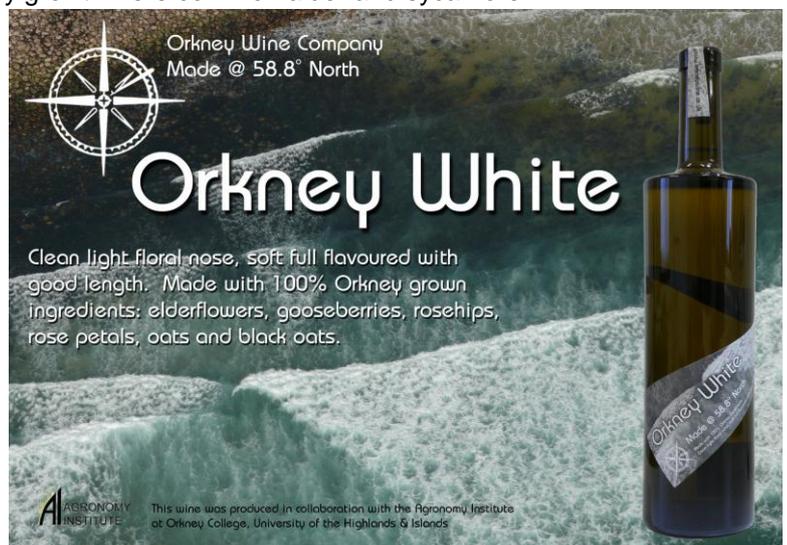
Short Rotation Forestry (SRF) Project

Since 2011, the AI has been collaborating with Forestry Commission Scotland to investigate the potential of SRF in Orkney and, in 2013, is establishing two SRF trials, one of which will be "on-farm". The trials will concentrate on investigating the growth of different tree species and will provide information on SRF under Northern Isles conditions to complement trials already established by the Forestry Commission on mainland Scotland (<http://www.forestry.gov.uk/forestry/INFD-85UFMB>). As a precursor to the trials, tree growth and biomass production were estimated for seven different tree species growing at close spacing in Glaitness woodland, Kirkwall. At this site, the most promising species for rapid early growth were common alder and sycamore.

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. Although the company would like to source as many of its ingredients as possible locally, there are practical limitations on this because many fruits are irregularly available and/or much more expensive than from external sources. The AI grows a number of northern berry species which are uncommon in Scotland and a collaborative project between OWC and the Institute is assessing the potential for these to be used by the company to produce unusual wines with a high proportion of local ingredients. The project is being assisted by chemical analyses of the berries and wines carried out by the James Hutton Institute and the Rowett Institute of Nutrition and Health. 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.



Orkney White, a new wine produced by Orkney Wine Company as a result of collaboration with the Agronomy Institute.

6.4 Amenity Horticulture

New Plants For The Northern Periphery (NPNP)

This project (<http://www.northernplants.net/>) was funded by the Northern Peripheries Programme and included partners in Sweden, Finland and Iceland as well as the AI. The aim of the project was 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 selected a number of hardy ornamental plants which grow well in their own region. Based on a questionnaire sent out to stakeholders and



The Orkney demonstration garden of the New Plants for the Northern Periphery Project.



discussions with specialists, each partner selected a number of plants for testing from the other partners. These plants were then established in demonstration areas / gardens in all the partner countries where they are being shown to the public through open events. Links with the commercial sector, which have been built up during the project, will then be used to market the best of these plants. In Orkney, the AI worked with horticulturalists at Orkney College and St Colm's Resource Centre to establish the demonstration garden. Plants were also sent to COPE in Shetland for testing. The project finished at the end of August 2012, following a final conference at Rovaniemi in Finland earlier in that month. Examples of the Best Practice Guidelines prepared for two of the selected Orkney plants (Scotch Laburnum and Daisy Bush) are shown below.

Best Practice Guidelines



Scotch Laburnum
Laburnum alpinum

Origin
This species originates from southern and central Europe and was introduced into Britain in the 16th Century. It is a hardier species than the common laburnum (*L. anagyroides*).

Outstanding features
A small tree that produces beautiful, long, hanging clusters of yellow, pea-like, fragrant flowers.

Description and characteristics
A small, deciduous tree which can grow to 4-6 m in favourable locations. The foliage is alternate with trifoliate compound leaves. The underside of the leaflets and stems are silver/grey and hairy. The leaflets are oval. The flowers appear in June in long, hanging racemes, usually at least 20 cm long. The flowers are bright yellow and pea-like. The fruit is a pod and these hang from the racemes. They are about 2.5 cm long and turn brown when mature; they contain black seeds which are very poisonous.

Planting location and recommended use
This plant is probably best grown on garden boundaries where there is room for its mass of flowers to be appreciated. It is resistant to wind and, in Orkney, is often planted near the sea. The wood is very hard and excellent for turning, differences in colour between the outer wood (creamy yellow) and heart wood (dark brown) make it attractive for veneer. It is hardy in Orkney and is being tested in the project in Finland and Sweden.

Propagation
It can be propagated easily by seeds sown inside in the autumn. Plants should be ready for planting in their second year.

Warning
All parts of the plant, especially the seeds, are poisonous.

References
Cox, K, and Curtis-Machin, R. 2008. Garden Plants for Scotland. Frances Lincoln Ltd, London.
Hillier's Manual Of Trees And Shrubs. 1984. 5th Edition. David & Charles, London.





Best Practice Guidelines



Daisy Bush
Olearia semidentata

Origin
This species originates from the Chatham Islands, 750 km to the East of New Zealand where it is found on peaty, boggy land. It was introduced to Britain in the early part of the 20th Century. Although normally only recommended for mild, coastal parts of the UK, it survives and flowers well in Orkney.

Outstanding features
Produces a mass of large mauve flowers in July and August. Attractive foliage, dark green on top, white underneath.

Description and characteristics
An erect evergreen shrub or small tree growing to 2-3 m tall. Leaves are 4-8 cm long, narrow and lance shaped and toothed towards the tips. The foliage is dark green on top and white underneath. Leaves and young branches are covered by white hairs. Plants produce a mass of large (5 cm diameter) mauve flowers in July and August which gradually fade as they age. It does not transplant well and does not produce shoots from old wood on pruning.

Planting location and recommended use
This plant is probably best on garden boundaries as it requires room to grow and sufficient space for its flowers to be seen. It needs to be treated as a small tree rather than a hedge because it does not respond well to pruning. Although tolerating wind, it benefits from the shelter of other plants around it. It is good for coastal locations as it tolerates salt spray. It is hardy in Orkney and is being tested in the project in Iceland.

Propagation
Plants can be propagated by seed or by semi-hardwood cuttings.

References
Cox, K, and Curtis-Machin, R. 2008. Garden Plants for Scotland. Frances Lincoln Ltd, London.
http://www.nzpcn.org.nz/c/flora/factsheets/NZPCN_Species_608.pdf












7 Staff

The following staff worked at the AI over the period:

Dr Peter Martin - Director
Mr Billy Scott - Field Trials Officer
Mr John Wishart - Technician.

8 Publications

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



- Brereton, N.J.B., Ray, M.J., Shield, I., Martin, P., Karp, A. and Murphy, R.J. (2012).** Reaction wood – a key cause of variation in cell wall recalcitrance in willow. *Biotechnology for Biofuels* 5:83.
- Martin, P. (2012).** Single malt Scotch from 59° North. *Brewer & Distiller International* 8 (7), 45-47.
- Martin, P. (2012).** Orkney bere for Arran whisky. *Brewer & Distiller International* October 8 (10), 41
- Martin, P. (2012).** Report to Forestry Commission Scotland on Phase One of a Project to Establish Short Rotation Forestry Trials In Orkney. Orkney College UHI.
- Martin, P. (2013).** Report to Highland Park Distillery on the performance of an Orkney supply chain for malting barley in 2012. Orkney College UHI.
- Martin, P. and Chang, X (2013).** Production potential and crop agronomy of sweet gale (*Myrica gale* L.) in the north of Scotland. *Industrial Crops and Products* 46, 39-49.

9 Contacts

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