Northern Cereals

Northern Periphery and Arctic Programme 2014–2020

EUROPEAN UNION
Investing in your future
European Regional Development Fund

Northern Periphery and Arctic Programme

Northern Cereals – New Markets for a Changing Environment

PRODUCING MALT IN ORKNEY FROM LOCALLY GROWN BARLEY FOR THE SWANNAY BREWERY

A Case Study

Activities 6.1 and 6.2

By

Peter Martin

Agronomy Institute, Orkney College UHI

November 2015

AGRONOMY INSTITUTE

University of the Highlands and Islands Orkney College

Northern Periphery and Arctic Programme
Northern Cereals – New Markets for a Changing Environment
CAV Diary Number 304-8673-2014

PRODUCING MALT IN ORKNEY FROM LOCALLY GROWN BARLEY FOR THE SWANNAY BREWERY - A Case Study

Author:

Peter Martin

With contributions from:

Highland Park Distillery, Orkney

Swannay Brewery, Orkney

Northern Cereals Partners:

Matis – Icelandic Food and Biotech R&D

Agricultural University of Iceland

Norwegian Institute of Bioeconomy Research

Agronomy Institute, Orkney College UHI

Agricultural Centre, Faroe Islands

Forestry and Agrifoods Agency; Newfoundland and Labrador, Canada

CONTENTS

1 Introduction

As a result of increasing consumer demand for high provenance beers, Orkney's Swannay Brewery has been collaborating with the Agronomy Institute at Orkney College UHI since 2014 to develop beers using locally grown barley. An initial trial in 2014 used grain of Bere, a traditional Scottish barley which has been grown in Orkney for many hundreds of years. The project produced a very successful beer, but because small-scale malting facilities were not available in Scotland, the grain had to be sent to England for malting. Apart from being costly, both partners agreed that a more local solution to the malting was desirable. With good collaborative links between the Institute and Highland Park Distillery, which still maintains a traditional floor malting capacity, the Institute and brewery started discussions with the distillery about the feasibility of the distillery producing small quantities of malt for the brewery. The Northern Periphery and Arctic Programme Northern Cereals project provided an opportunity for this to be investigated further and had the added advantage of demonstrating and testing the process for other partners in the project.

On a small scale, floor malting is a relatively simple process which could be used by remote breweries or distilleries in the Northern Periphery area to produce their own malt and increase the provenance of their products while also helping them reduce their carbon footprint. During the Northern Cereals preparatory project, several partners reported that local breweries had expressed an interest in being able to produce their own malt. Consequently, it was decided to explore the feasibility of floor malting within the main Northern Cereals project and to do this based upon the initial experience gained during the collaboration between the Agronomy Institute, Swannay Brewery and the distillery.

The results of the Orkney feasibility study are presented in Section 3 of this report and are preceded by a brief, general review of the floor malting process. A comprehensive set of photographs, illustrating the malting process in the feasibility project, is presented in Appendix 1 at the end of the report.

2 Floor Malting

2.1 Introduction

Up until the 20th century, most Scottish distilleries produced their own malt on-site using traditional floor malting. From then there was a gradual shift to less labour intensive methods like drum malting and Saladin box malting and eventually to abandoning distillery malting and using very large-scale centralised facilities instead. Consequently, there are now only about seven Scottish distilleries which still have their own facilities for malting barley and most of these use floor malting. Although this is a much more expensive process than purchasing malt from large malt suppliers, it has the major advantage of providing these distilleries with a unique malt which adds to the provenance of their whiskies. It also allows these distilleries to source locally grown barley and to produce whiskies with 100% local content. This can be a significant *unique selling point* in the whisky market where product differentiation is very important. In remote areas, the availability of malting facilities at distilleries raises the possibility of additional benefits to breweries and growers if these distilleries are prepared to malt local barley for brewing.

2.2 Stages In Floor Malting

Malting is the process whereby cereal grains are allowed to start to germinate so that the chemical changes necessary for brewing or distilling are started. Germination is then stopped, before it progresses too far, by drying the grains. This also creates a product which has good storage properties.

For malting, it is necessary to have good quality grain with a high germination percentage. Some varieties may need to pass through a period of dormancy to give maximum germination. The quality criteria for barley used for malting will be considered in more detail in a different Northern Cereals project report.

The raw material for most malt is usually barley grains. These will normally have been dried down to about 13% moisture content for safe storage. To start the germination process, the moisture content of the grain needs to be raised and this is done by immersing or “steeping” it in water. For this, the barley is placed in a steeping vessel and immersed in water for several hours; the water is then drained away. Steeping and draining are then repeated several times over about a two-day period. At the end of this stage, the grain should be at a high moisture content (about 45%) and the coleorhiza or root sheath (“chit”) should be starting to appear at the base of the grain.

Next, the grain is removed from the steeping vessel and spread out or ‘cast’ on a malting floor (usually smooth concrete). Here, germination continues over several more days during which rootlets start to emerge. As germination progresses, the grain needs to be turned several times to provide uniform conditions and to prevent overheating and the rootlets from matting together. During germination the barley grains produce the enzymes which are needed later in the brewing process to convert starch and polysaccharides into sugars. Underneath the husk of the grain, the coleoptile (or acrospire, which encloses the first leaf) starts to grow and the malt is usually ready when this is about the same length as the grain, but before it emerges. At this stage the germination process needs to be stopped.

This is done by moving the grain to a drying floor where it is exposed to hot air (“kilning”) and drying it down to a very low moisture content (less than 6%). Dry malt is very stable and stores well in sealed plastic bags. Before the malt is used for brewing or distilling, however, it will need to be milled.

3 Feasibility Project

3.1 Introduction

The three Orkney partners agreed to test the feasibility of using Orkney-grown barley for making into malt using the distillery’s traditional floor malting facilities. For this, the brewery was able to source Orkney-grown ‘Golden Promise’. This is a variety which was developed for malting in the 1960’s and is still grown by a few farmers in the North of Britain, including Orkney, because of its earliness. Although surpassed for yield by more modern varieties during the 1980’s and 1990’s, its malting quality is good and it is still used for niche market products by some breweries.

A preliminary examination of the malting process used by the distillery indicated that the only major problem in producing malt for the brewery was likely to be the removal of the dried malt from the drying floor of the kiln and putting it into tote bags outside the kiln, instead of allowing it to follow its normal processing route within the distillery.

3.2 Floor Malting Of Orkney-Grown 'Golden Promise'

3.2.1 Steeping

For steeping, about 7.5 t of grain were put in two vessels (c. 3.75 t in each) and steeping started at 12:00 on 10 March 2015. The temperature of the water going into the steeping vessel was raised to 14^{o} C but this was then allowed to drop (to about 11^{o} C) during steeping. The grain underwent 3 sessions of steeping as summarised in Table 1. By the end of steeping, grain moisture content reached 43.1%.

Table 1. *Cycles of steeping and draining for "Golden Promise" in the feasibility study.*

Activity	Start (time and date)	Duration of steeping (h)	Grain moisture (%) at end of steeping session
First steep	12:00 on 10/3/15	8	33.9
Drain	20:00 on 10/3/15		
Second steep	10:00 on 11/3/15	10	41.0
Drain	20:00 on 11/3/15		
Third steep	08:45 on 12/3/15	4	43.1
Drain	12:45 on 12/3/15		

Photos 1 to 4 show different stages in the steeping process.

3.2.2 Casting and floor germination

After the water had drained away at the end of the last steeping session, the grain was unloaded from the steeping vessel, cast on the floor and then spread out on the malting floor to a depth of about 10 cm (Photos 5 to 7). This required a floor space of about 220 m^2, indicating a space requirement of about 29.3 m^2 per tonne of grain. The grain was on the malting floor from 14:00 on 12 March until about 09:00 on 18 March and was turned (or ploughed) about 3-4 times daily using specialist equipment (Photos 8 and 9). In earlier times, wooden malt shovels would have been used – one of these can be seen in the photograph on the cover of this report. A general view of the malting floor is shown in Photo 10 while the extent of rootlet growth by the 18 March can be seen in Photo 11.

While the malt was being made on the floor, the temperature within the malt bed, and air temperature about 1.0 m above it, were recorded every 15 min using temperature sensors

(TinyTag) at three locations. For comparison, air temperature outside the malt house was also monitored during this period. Average temperatures for the three environments are shown in Fig. 1. Over the malting period, the outside air temperature fluctuated from lows of 3-6° C at night to day time highs of 5-8° C. Air temperature within the malt house was more stable (7-9° C). Malt temperature initially dropped from about 11° C after leaving the steeping vessel to about 8.5° C after several hours on the floor, but then gradually rose during malting to just over 14° C on the last day. The dips in the trace of the malt temperature show where it was turned.

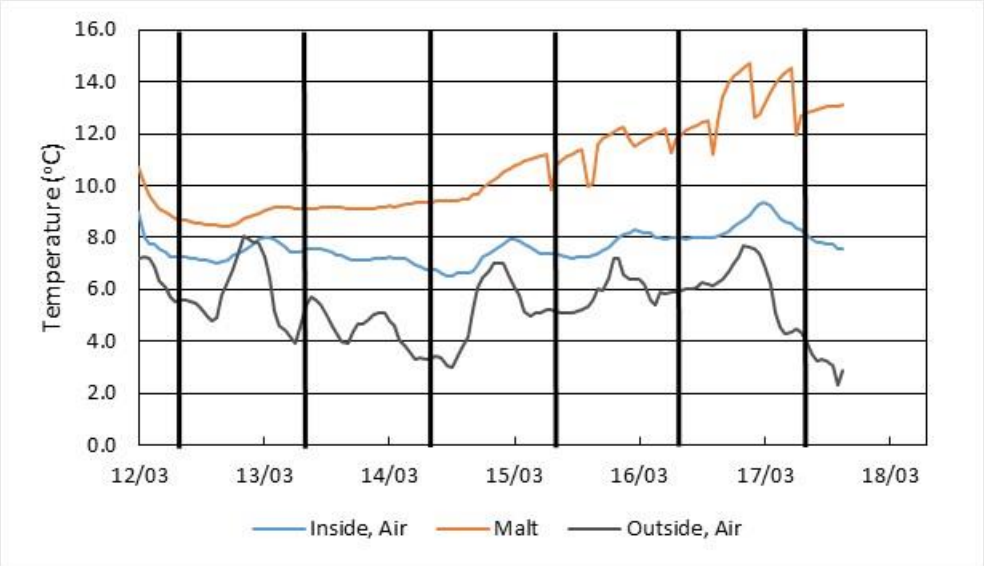

Fig 1. *Temperature during malting of i) the air inside the malt house, ii) the malt and iii) the outside air.*

3.2.3 Kilning

The grain was cleared from the malting floor on 18 March using a small plough blade which was pulled by a cable and winch system controlled by the operator (Photo 12). This pushed the grain to a hole in the floor where it fell onto an auger taking it up into the kiln on the first floor of the building. Here, it was discharged into barrows (Photo 13) and then spread over the drying floor made of wedge wire panels. The fuel used by the kiln fire (Photo 14) was smokeless anthracite and this was started at 11:00 on 18 March when the grain had a moisture content of 43.9%. Although some peat is often used by distilleries during the drying of malt, this was not used for the 'Golden Promise' malt because peated malt is not liked for brewing. Initially, the kiln was set to give a grain temperature of 45-50° C but this was raised to 65° C from 23:30 on 18 March. The kiln fire was stopped at 18:30 on 19 March and the malt emptied from the kiln on the following morning. By the end of kilning, the moisture content of the malt was 3.8% which is lower than the distillery normally aims for, but is what the brewery had requested. While on the kiln floor the grain was turned mechanically by a large horizontal auger twice to even out the drying.

As the distillery does not normally produce malt for other organisations, a temporary solution had to be devised for taking the malt out of the kiln and it was therefore unloaded by emptying it through a window in the kiln room, via a metal chute, into tote bags supported by a telescopic loader (Photo 15).

3.2.4 Analysis Of Malt

An analysis of the malt using standard Institute of Brewing (IOB) methods is provided in Table 2 which also provides typical current-day minimum and maximum specifications for each analysis. While a number of the analyses of the malt are out of the range considered optimal in commercial malt, it is important to stress that the 'Golden Promise' had been grown for seed by the farmer and it was only after the harvest that it was decided to use it for malting. Also, of course, 'Golden Promise' will not produce the malt specifications expected from recently released varieties. Amongst the analyses, glucan content is particularly high while extract, friability and homogeneity are low.

Table 2. *Laboratory analyses of 'Golden Promise' malt.*

Analysis	Result	Minimum	Maximum
Colour on IOB 450g mash	2.0	3.5	5.0
Colour (quick check)	2.0	4.0	6.0
Moisture (%)	5.3		3.7
Extract Miag 7 "Dry" LDK	293.7	306.0	
Extract Miag 7 "As Is"	278		
Total nitrogen (dry %)	1.53		1.55
Total soluble nitrogen (% dry)	0.52	0.58	0.68
Soluble nitrogen ratio	34.0	38.0	44.0
Friability (%)	71	90	
Homogeneity	92	98	
Steely corns (%)	3.1		2.0
Glucan in wort (ppm) IOB	218		120
Diastatic power IOB "dry"	48	40	65
Diastatic power IOB "as is"	45		
Cold water extract (%)	16.6	16.0	

4 Brewery Report

The account below provide feedback on the malt from Swannay Brewery and was prepared by Lewis Hill, Managing Partner at the brewery.

In the increasingly competitive beer market there's an ever growing need for beers with a "unique selling point" to stand out from the rest. Using locally grown ingredients is a good way of achieving this and creates a lot of further marketing advantages at the same time - locally grown is good for our carbon footprint, it keeps money in the local economy and undoubtedly reinforces one of our core values - of supporting, and taking an active part in, the Orkney community.

While 'Golden Promise' is a variety that is used in brewing, it is not one we normally use at Swannay and so the project provided us with a useful opportunity to experiment with it. Although the amount of grain (c. 7 t) that we malted was perhaps more than ideal for a trial run, this was the minimum quantity which the malting facility could cope with. We were very happy with the practical aspects of the malting, although in the future it would be useful to develop a more efficient bagging method.

Due to our set up at Swannay we had to send the bagged (6 x 1 t) malt to Norfolk in order to have it milled to our standards and then bagged in 25 kg sacks. This was an unfortunate, but unavoidable, cost and use of fuel. In the future, with better facilities at our brewery, we should be able to store the malted barley in bulk and mill as required to suit our brewing schedule.

The first brew we made with the malt was a 5.0% ABV pale beer that we named Yardsook – this is an old Orkney name for a drying wind that dries the crops before harvest. A yardsook wind may well have dried the 'Golden Promise' before it was harvested in Dounby. Of beer's four main components - water, malt, hops and yeast - Yardsook has three ingredients of Orkney origin. It was a little disappointing that for the fourth component, hops, we had no Orkney supply and had no alternative but to use American hops.

Feedback in the brewery and from the public was positive about the beer. The 'Golden Promise' malt definitely gave the brew a rich, full flavour that we do not obtain from our regular base malt, Maris Otter. Extract-wise, the malt was significantly lower than commercially malted barley, though this was expected. We have recently blended approximately 10% 'Golden Promise' into our annual batches of Orkney Porter and plan to do another all-'Golden Promise' batch of beer to age in Isle or Arran Bere Whisky casks - this will further compound the Orkney story.

5 Discussion

The feasibility study showed that there was no major difficulty in the distillery using its facilities to produce malt from Orkney-grown barley for a local brewery. Clearly for this to be repeated it will need to be viable financially for both parties and will need to be managed so that it results in minimal interference in the distillery's malting activities for its own purposes. The minimum quantity of grain which can be malted by the distillery for the brewery is about 7.0 t as this is the capacity of the steeping vessels and also corresponds to one load on the

drying floor of the kiln. It is likely that this is a much larger quantity of grain than most microbreweries would initially want to malt.

For partners in the Northern Cereals project, this Orkney feasibility study has documented the steps which floor malting requires, but the partners will need to find their own solutions for developing the equipment required to carry out the process. A major factor influencing this will be the amount of malt required to be made in each batch – as this increases, so does the need for specialist equipment. The key items of equipment/facilities required are:

- Steeping vessels which can be easily filled and emptied of both grain and water
- A sufficiently large floor space for the floor malting
- Depending on scale, mechanical devices to assist with turning the malt and clearing the malt floor; these should also be suitable for use on the drying floor
- Drying facilities which allow the temperature of the malt to be controlled
- Bagging equipment, if the malt is to be stored. Air-tight bags are required for long-term storage
- Milling equipment for grinding the malt before it is used

It should be stressed that while floor malting is a fairly simple process, without appropriate machinery/equipment, it can be very labour intensive. Consequently, if project stakeholders are considering doing this on any scale, the design of the facilities and selection of equipment must take into account the need to reduce the labour input as much as possible.

Temperature could be an issue for partners in regions with more extreme temperatures than Orkney. Average monthly outside temperatures in Orkney can range from about 4^{o} C in the winter to 14^{o} C in the summer. This range of temperature does not present any major problem for floor malting in stone, unheated buildings although the process is quicker at the higher temperatures. In Orkney, the distillery gives the germinating barley an extra day to grow during the cold days of winter and all the windows and doors are closed in an effort to keep heat in. A portable gas space heater is also used occasionally when it is very cold. In other regions, floor malting in unheated buildings may not be possible over parts of the winter if temperatures are much lower than 4^{o} C. If a brewery is considering establishing a floor malting facility in a colder climate, it might be possible to use ‘waste’ heat from either the brewing and/or the kilning processes to warm the germinating floors. High summer temperatures could also make it more difficult to control the process and may result in a less uniform product.

Acknowledgements

The author is especially grateful to staff of Highland Park Distillery for agreeing to carry out the malting and for providing information about the process, and access to the malting floors during the trial. It was also a pleasure to work with Swannay Brewery on this project.

It should be stressed that the malting of ‘Golden Promise’ at Highland Park Distillery was purely to produce malt for the brewery. This variety is not used by the distillery for whisky production and all steps were taken to ensure that grain of the variety did not enter the normal production stream.

Appendix 1. Photographs

Photo 1. Transferring grain into the steeping vessel.

Photo 2. Steeping vessel during the third steep.

Photo 3. Grain after draining following the third steep.

Photo 4. Grains at the end of steeping. The white tip of the coleorhiza (root sheath) can be seen at the base of some grains.

Photo 5. Unloading grain from the steeping vessel.

Photo 6. Casting steeped grain on the malting floor.

Photo 7. Spreading out the grain on the malting floor.

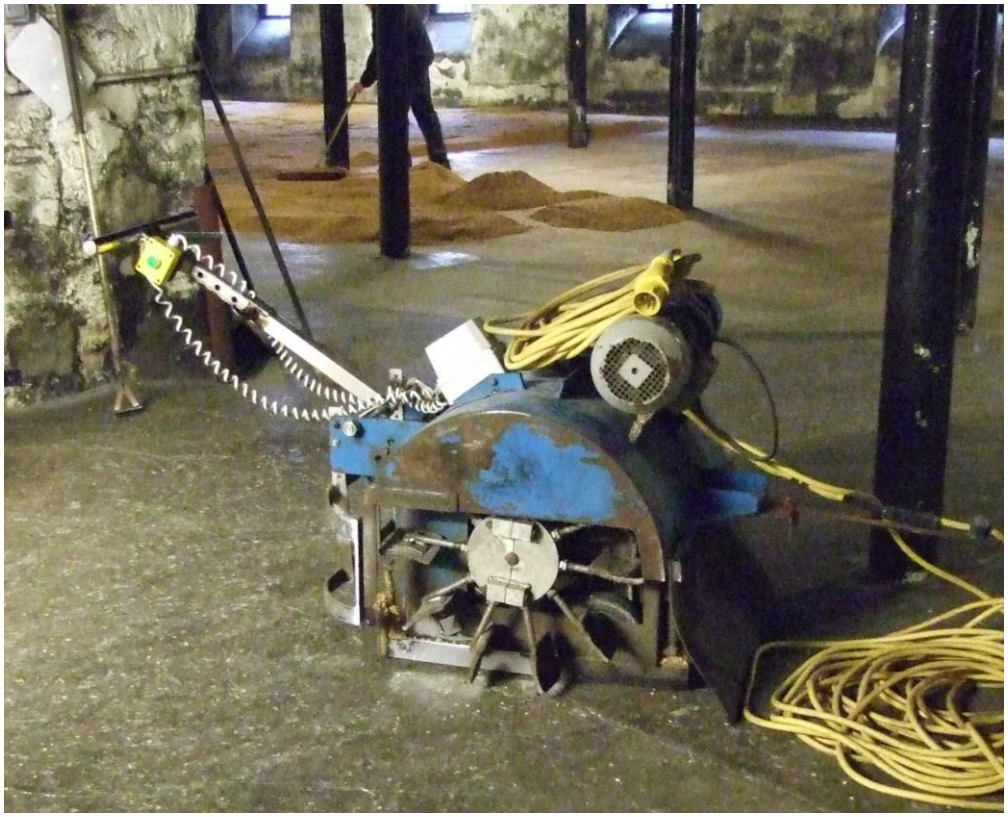

Photo 8. Machine used for turning malt

Photo 9. Manual rake used for ploughing the malt.

Photo 10. General view of the ‘Golden Promise’ spread on the malting floor.

Photo 11. ‘Golden Promise’ grains on the last day on the malt floor, just before kilning.

Photo 12. Clearing the malt floor

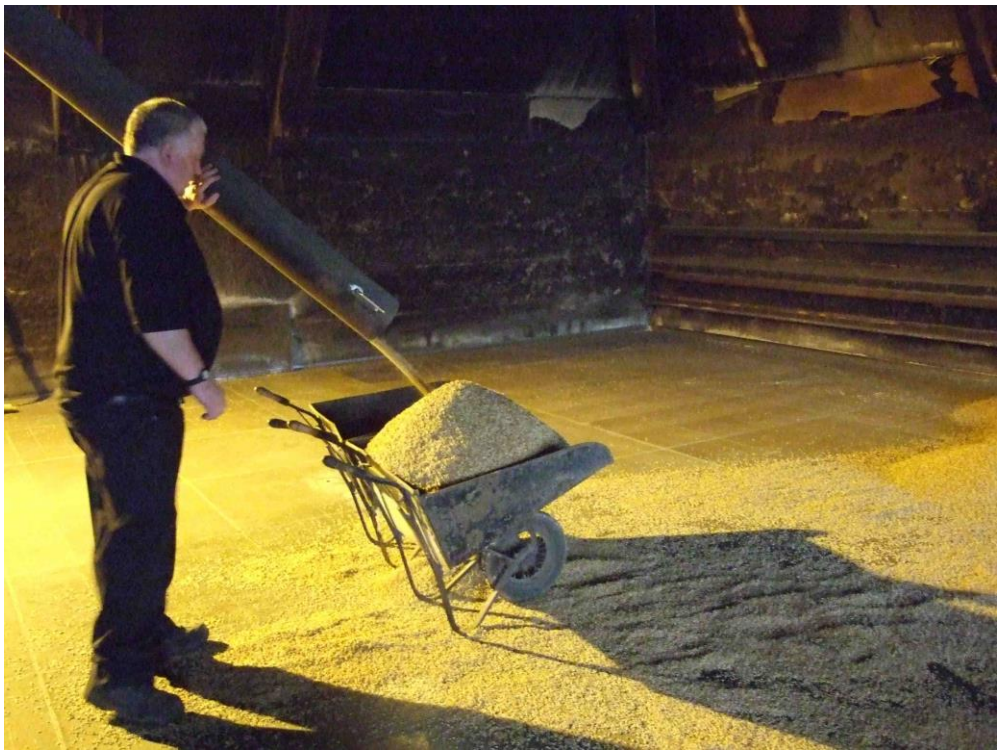

Photo 13. Spreading the green malt on the kiln floor.

Photo 14. Kiln fire.

Photo 15. Unloading malt from the kiln.