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Technical Pulses

A virtuous spirit

The Arbiikie Highland Estate in Scotland is noted for the award-winning spirits distilled on site from a staggering array of local produce. CPM visits to find pulses may soon form the basis of the industry's first-ever carbon-positive product.

By Tom Allen-Stevens

If you enjoy a good whisky, the lines of barrels that stretch away into the gloom of the store at the Arbiikie Highland Estate Distillery will fill you with anticipation. But you'll have a long wait, explains John Stirling, director of the diversified business and fourth-generation farmer on the 900ha family-owned estate near Montrose on the east coast of Scotland.

"It's laid down as an 18-year old single malt that won't be released until it's correct," he says, which takes it to 2033 at the earliest. "It's a long-term project, so what makes the business model is the gin and vodka we distil. Underpinning this is that everything is grown and bottled on the farm, which gives us complete control over the

quality and provenance of the product."

Nor is this just a marketing gimmick, John counters. "It started as a sensible marketing strategy, but actually it's way more important than that. Now it influences everything we do on the estate, from how we grow the crops to the rotation itself."

Staggering array

This has paved the way to a plan that will see oilseed rape dropped from the all-arable seven-year rotation across the estate's red sandstone soils. Alongside spring and winter barley, wheat and 140ha of potatoes, next year peas are set to be reintroduced. These, along with a staggering array of other crops, will also go through the still, provided the first — and somewhat ground-breaking — commercial test batch goes to plan, and this is due to take place early in the New Year.

The story starts around six years ago when the estate took its first steps on a new path, led by the three brothers who took on the family business. "We each had different backgrounds," explains John. "Iain had worked in the drinks industry, David was in marketing, while I had trained as an accountant."

Their combined skills led them to a gap they identified in Scotland's growing market for craft distilleries. "70% of spirits consumed in the UK are made in Scotland, and there's a booming export market. But most of the UK's gin, even from so-called

craft distilleries, is produced using bought-in grain-neutral spirit. Our aim was for a genuinely single-site, field to bottle operation. We wanted all the ingredients for all our spirits planted, sown, grown and harvested close to the distillery."

The key to making it work has been the skill of master distiller Kirsty Black, who joined the business in 2013, having completed an MSc programme in brewing and distilling at Heriot-Watt University. "We started with just an empty shed and it was the farm's potato crop that was the initial driver for the still," she explains.

"While the barley crop had always been grown for the premium malting market, as ▶



What drives it for Kirsty Black is the experimentation, and for her, the raw materials are as important as the end product.



Brothers (L to R) Iain, John and David Stirling combined their skills and identified a gap in Scotland's growing market for craft distilleries.

► much as 10% of the potatoes can't be sold into premium markets because they're a funny shape, bruised or skinned."

This shaped how the distillery developed — while the barley, malted off site, is processed and distilled for the whisky, the misshapen potatoes form the basis of a vodka, distilled through two tall copper columns on one side of the shed.

"Vodka is traditionally a potato spirit, although the raw material doesn't have the natural enzyme present in wheat and barley that turns the starch into alcohol — this has to be added. Nor does it produce as much — one tonne of grain gives you about 400 litres of alcohol, compared with 100 litres from the same amount of potatoes."

There are subtle differences between a potato and grain-based vodka, claims Kirsty, and this is where the master distiller's art comes into its own. She uses the shape of the still and tweaks the process itself to bring out the flavour in the end product. "A range of factors affect the congeners, which are biologically active chemicals produced during fermentation. What I'm particularly interested in is how you can influence the congeners through the choice of raw material."

But she acknowledges these differences are probably too

slight for the average consumer to notice. "A premium straight vodka is never going to sell in high volumes, so what we do is flavour it with juniper and botanicals and put it through the still again to produce a gin. It's a question of choosing the right botanicals to complement the congeners."

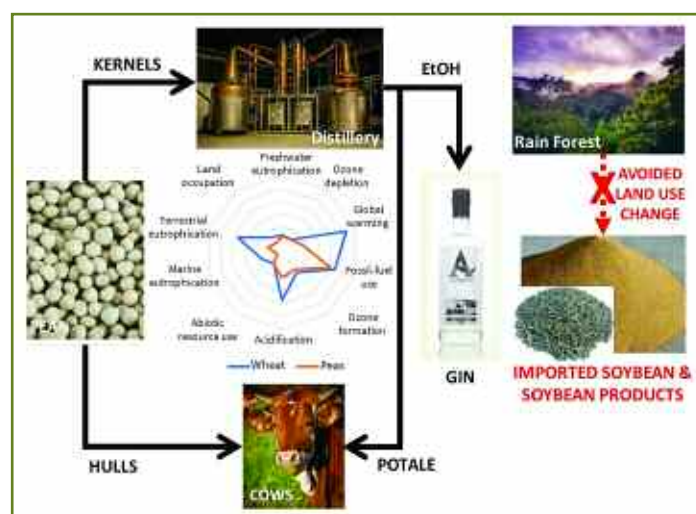
So the distillery has come to six products it bottles and puts on sale from farm produce that can be traced back to the field. Three are made from potatoes, a blend of Maris Piper, King Edward and Cultra, with Tattie Bogle, a Scot's name for a potato scarecrow, as the unadulterated pure spirit. Home-grown chipotle chillies are also soaked in it to produce Arbikie's Chilli Vodka, while Kirsty's Gin brings in kelp, carline thistle and blaeberrries from the local landscape.

The other three are wheat based, with Group 3 variety Zulu now giving way to Viscount as the variety of choice to produce the pure, Haar Vodka, named after the local coastal fog. Peter Stirling, a cousin who farms next door, supplies fruit to flavour Arbikie's Strawberry Vodka. Black pepper, cardamom and locally produced fresh honey flavours AK's gin, named after John's father Alexander Kirkwood Stirling, with £1 per bottle donated to a local motor neurone disease charity.

Inventory of inputs and outputs for a single batch of gin

	Units	Wheat	Pea
Cultivation and harvest			
AN	kg	44	0
Urea	kg	18	0
P ₂ O ₅	kg	17	39
K ₂ O	kg	25	20
Lime	kg	209	245
Diesel	kg	85	52
Seed	kg	27	123
Agrochemical		2	1
Land	m ²	4182	9811
Output			
Grain	kgDM	2703	4558
Used in grist	kgDM	2703	2782
Straw	kg	1871	0
Residual N*	kg	23	58
Gin produced	L	1886	
Potale used as fertiliser			
Potale produced	L	10,547	
Transport	t-km	53	
spreading	m ³	11	
Fertiliser contribution			
AN	kg	-27	-59
P ₂ O ₅	kg	-20	-25
K ₂ O	kg	-22	-27
Net land occupation	m²	4149	8110
Net global warming potential	kg CO₂ e	5847	2075
Potale used as animal feed			
DDGS produced	kg	1213	1514
Transport	t-km	109	136
Energy	kWh	201	250
Pea hulls processed as pelleted feed			
Pellets produced	kg	-	1777
Transport	t-km	-	571
Energy	kWh	-	407
Avoided animal feed			
soybean meal	kg	-628	-2243
barley grain	kg	-569	-542
Net land occupation	m²	189	3395
Net global warming potential	kg CO₂ e	3772	-4149

Source: T. Lienhardt, et al., 2019. The inputs and outputs of the distillery operations, gin bottling and packaging were included in the study and were the same for peas and wheat, although they're not shown here. *Residual N assumes wheat straw is incorporated. Inputs and outputs of de-hulling the peas are only included in the net results where potale was used as animal feed.



Taking into account the potential to displace soymeal and its associated environmental costs, gin made from peas comes out carbon-positive in a life cycle assessment.



The polytunnel at Arbikie where Kirsty grows and tries out different botanicals.

Launched just five years ago, the field-to-bottle spirits been a great success by any measure. But Kirsty is particularly pleased with the awards they've earned. "The first major one that got us noticed in the UK was a bronze medal at the 2016 World Vodka Awards. There have been quite a few since, including inaugural winner of both Gin Distillery of the Year and Best New Whisky Distillery in Scotland, and it's the gins that have been the most successful — when bottles start going out on large pallets, rather than in small boxes you realise things are taking off."

What drives it for Kirsty is the experimentation. "I was always told that strawberries are the hardest to capture in a spirit, but we may have found the secret. To us, the raw materials are as important as the end product — there's so much more to their properties than hot water extract and nitrogen content. It's through exploring these that you can discover new experiences in the spirit."

And that's led her to perhaps her most ambitious project — exploring the distilling potential of leguminous crops, and faba beans and peas in particular. It's a PhD study she's carrying out with James Hutton Institute and Abertay University, started in 2014. "You can make alcohol from anything with a starch content. The difference with peas and beans is they're much better environmentally," she notes.

Small-scale trials in the lab have proved



The two tall copper columns distil the pure spirit, while it's the shape of the still, along with choice of raw materials and distiller's art that defines the taste.

the concept that peas and beans are a suitable raw material for distilling. "In the lab we can't recreate the purity of spirit we can in the distillery itself. But we've carried out blind tastings with the resulting vodka and believe the spirit to be comparable to that produced from potatoes or wheat."

TRUE project

Kirsty's study is part of the wider TRUE Project (TRAnsiTion paths to sUstainable legume based systems in Europe), funded under the EU's Horizon 2020 programme. This aims to identify the best routes to increase sustainable legume cultivation and consumption across Europe. It consists of nine work packages, carried out by R&D institutes across Europe and co-ordinated by JHI.

"The real story with distilling pulses lies in the protein value of the dried distillers grain with solubles (DDGS)," says Dr Pietro Iannetta of JHI. Potale — the by-product of the distilling process — is a liquid of around 8-10% solids, which typically contains 25-60% protein. This is currently applied as a liquid fertiliser on the Arbikie Estate. There's also the "draff" — the spent cereal grains from the mash — which, once dried to DDGS, contain around 33% protein, and form a valuable animal feed.

"Initial tests from small-scale trials carried out by Horizon Proteins, based in Heriot-Watt University, indicate DDGS from pulses can have their protein concentrated to more than 90%. If that valorises, or holds true at a commercial scale, it could make a significant contribution to replacing the UK's grain legume requirement — 80% of this is currently supplied with imported soymeal." Scotland's farmed salmon industry is a ready market for the high protein feed, he adds.

As part of the TRUE project, a life cycle assessment (LCA) has been carried out on peas used in distilling compared with wheat, using figures supplied by the Arbikie Estate. This takes account of all input and output resources and assesses the environmental burden across 14 impact categories, including land occupation and global warming potential (see table on p24). The LCA of the gin on its own was assessed, and then the study was expanded to account for the potential for the by-product to replace applied fertiliser or soymeal.

Peas score favourably against wheat, mainly as a result of the crop's ability to fix its own nitrogen — applied fertiliser has a very high carbon footprint. But this advantage is largely offset by a higher land requirement attributable to its lower yield. Once the value of the by-product is taken into account,



Pietro Iannetta believes there's great potential to scale up the use of legume starches in production of alcoholic beverages and biofuels, while also delivering home-grown sustainable protein.

however, it changes the figures significantly. Such is the potential to replace South American soymeal, with its high transport and deforestation costs, pea gin and associated by-products actually come out carbon positive.

"Each litre of bottled pea gin avoids 2.2kg CO₂e and makes use of two of Scotland's great industries — alcohol and aquaculture," notes Pietro. Currently less than 1% of Scotland's arable area is cropped with legumes at present, but 15% should be the aim for a more sustainable approach, he believes, and adds that there's good demand for the high-protein feed from the DDGS.

"This is an opportunity to re-establish the natural nitrogen cycle within a sustainable cropping programme, and there's great potential to scale up the use of legume starches in production of alcoholic beverages and biofuels, while also delivering home-grown sustainable protein."

While the future of pea gin hinges on the first commercial test batch, due to pass through the Arbikie fermentation chambers and distilling columns next month, John has high hopes for what the new crop may bring to the estate. Exactly what type of peas will be grown has yet to be decided, but there's no OSR in the ground, and he has no regrets.

"OSR was the only non-cereal crop in the rotation, apart from potatoes, but it has few benefits and is heavily dependent on glyphosate, a chemical we're aiming to move away from," says John.

"Peas fix their own nitrogen and are so much better for the soil. We want to create a proper environment for growing crops and our passion with the distillery is for the raw materials that pass through it. We also want to make a real difference in the industry — if it's a success, we hope major companies will support spirits from legumes, put them into bars and restaurants worldwide and bring about a step change in global emissions." ■