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The Bioeconomy Consultants



Non-Food Crop Options for Jersey

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Executive Summary

The production of Jersey Royal potatoes has been a major contributor to the Jersey economy for many years. Due to their superior value when compared with alternative enterprises, they have commonly been cropped continuously on the same land, or as part of a very short crop rotation. This has led to the build-up of potato cyst nematode (PCN) which is a persistent pest with no limited or no effective and approved chemical treatment – the best method of control is breaking their production cycle by adopting a longer (up to 5 year) crop rotation.

The Jersey Royal acreage has declined by around 500ha in recent years and is expected to decline further in the short-term in an attempt to extend rotations and control the PCN problem. The island is therefore seeking alternative crop opportunities, to integrate into the crop rotations whilst remaining competitive, benefiting the local economy and ideally raising the profile of Jersey to in turn increase tourist visitor numbers year on year.

As an initial market scoping exercise, NNFCC have identified and reviewed a vast range of non-food crop opportunities across a number of sectors, including: medicinal herbs, pharmaceuticals, oleochemicals and novel oils, speciality food, bioenergy and algae. In order to qualitatively assess each opportunity the 26 showing the greatest promise in terms of production, manufacture and use were reviewed against a number of criteria, including: climatic conditions, agronomy, salt tolerance, market situation, value, potential for local use and ultimately their ability to improve the current PCN issue in the Jersey Royal potato crop.

Although resulting in high value outputs, the medicinal herb and pharmaceutical crops offered little opportunity for three main reasons: firstly, the crops are typically herbaceous perennials and therefore cannot be integrated into existing crop rotations; secondly, these herbaceous crops often require specialist planting and harvesting equipment which is not available on the island and would not be well used if introduced due to the small acreages involved; and thirdly, as these industries are highly regulated, there is no opportunity for local production and use, so it would not be possible to retain any additional value on the island.

The greatest market opportunity is apparent in novel oils for manufacture of personal care products. Within this sector, six crop species were identified as being highly suitable in terms of climate, agronomy, market, branding and local use potential, these were:

- AhiFlower
- Borage
- Evening Primrose
- Camelina
- Calendula
- Hemp

Each of these six crops is grown on an annual production cycle with most being spring-sown and early autumn-harvested, therefore integrating well with potato production as a means to extending existing crop rotations. They also use conventional planting and harvesting methods, for which equipment should already be available on Jersey, with capacity available at key times.

Within this market sector, there is also strong potential for local primary processing which in this case would be cold-pressing of oilseeds to extract unrefined oils – this process is simple and scalable from 10's to 100's of kilograms of seeds per hour. Equipment is widely available and relatively low-cost – a primary processing facility capable of pressing and filtering around 100kg per hour would cost less than £50k, with options to bottle, label and market cold-pressed oil for culinary use locally for an additional £30 – 50k (for bottling, capping and labelling equipment).

However, a higher value non-food opportunity is apparent in personal care products; whilst primary processing could still be undertaken on the island, filtered oils would be shipped to the mainland for further processing, product formulation and manufacture before being distributed and retailed nationally, globally or even returned to Jersey for local sale to the tourist sector, thus retaining maximum value within the islands economy.

In order to pursue this opportunity further work is required to explore the commercial potential, develop a business case and to identify specific gaps and investment needs for equipment, technology, skills and expertise.

Although opportunities were identified in other sectors, they were not scored as highly in the assessment phase primarily due to limited opportunities to deliver local benefits and less mature or lower value markets. Additional opportunities showing potential were speciality food (incl. samphire, truffles and asparagus) and bioenergy crops; although the former were excluded from the scope of this project (focus on non-food) and the latter were long-term perennial crops and thus were unable to assist directly with the PCN issue. These opportunities could potentially be considered alongside the speciality oils, to further extend crop rotations, to offer benefits to inland crops or to improve overall island self-sufficiency and sustainability.

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1 Introduction

The production of Jersey Royal potatoes is an important industry for the island of Jersey. The value of the crop compared to alternatives means that it has commonly been cropped on the same land continually, or on a very short rotation basis. This has led to the build-up of potato cyst nematodes (PCN) (*Globodera pallida* and *G. rostochiensis*). Prevention of these pests occurs through careful crop rotation and control traditionally relies on the use of nematicides. However, these products have gradually been withdrawn from use and / or are being phased out.

PCN is now a widespread problem through the island, to varying degrees and is resulting in both cosmetic potato skin damage and yield penalties affecting grower returns. Adopting an adequate rotational period (of 5 years or more) helps to reduce PCN incidence as part of a set of integrated control measures.

The Jersey Royal acreage stood at 3,500ha in 1997, but has declined to around 3,000ha now and could decline further to 2,000ha if 1,000ha of the worst effected land is taken out of production (300ha Category 4 and 1,000ha Category 3).

In addition to the reduction in area due to PCN occurrence, 2013 was a difficult season for the Jersey Royal industry with one of the worst winters on record, made worse by the exceptional snow in March. Delayed planting, additional costs and yield penalties resulted in slightly lower exports of 28,417 tonnes (171 tonnes lower than 2012) though a higher total gross return of £27.5M (£969/t) was achieved from the market¹.

In 2013, the total area of outdoor fruit and vegetables saw a reduction from 3,734 to 3,603ha mainly due to the fall in area of Jersey Royal potatoes from 3,235 to 2,949ha. Other fruit and vegetables fell by 20ha though the area of fruit and vegetables in organic production remained more or less static at 84ha. However, maincrop and other potatoes increased by 176ha (a 156% rise).

The States of Jersey Department of Environment wishes to identify other high value crops that could be included in the rotation to help improve the rotational practices while helping to offset the high land rents (by UK standards) and to reduce the financial impact of simply removing land from production.

Other crops including high value vegetables have been examined as alternatives, but economies of scale and the costs of shipping to the mainland have proven to be a hurdle.

The States of Jersey Department of Environment are therefore looking to examine what other alternative opportunities might be available from the non-food sector, recognising that

¹ Agricultural Statistics for 2013, Economic Development Department - <http://www.gov.je/Government/Pages/StatesReports.aspx?ReportID=1113>

there could also be opportunities for some on-island processing, to help reduce transport costs and retain value on the island.

The average size of holding in Jersey is around 70 vergées² (ca. 13ha); almost 50% of holdings have 0 – 10 vergées (ca. 2ha); 85% of holdings are less than 50 vergées (ca. 10ha) and less than 10% of holdings have 100 vergées or more (ca. 20 ha).

1.1.1 Project Aims

Traditional non-food crop markets tend to be characterised by small volumes of production and volatile prices, particularly in ‘uncontrolled’ markets where cheaper sources (e.g. China) can swamp markets and depress prices. There are a number of examples of this (e.g. Chamomile, Evening Primrose) or where alternative markets have depressed use (e.g. much Borage (Starflower Oil) has been replaced by algal products). However, market opportunities remain where provenance and local traceable supply chains are important factors.

Where markets have been tightly controlled (e.g. morphine poppy production) strong markets have developed and long-term relationships can be built. Unfortunately, there are very few examples of such controlled pharmaceutical crops. While many pharmaceuticals are based originally on plant-derived chemicals most of these can be synthesised chemically at lower cost.

Due to the infrastructure existing on the island of Jersey, although it may be difficult to identify successful examples of alternative enterprises, the potential for on-island processing and the ability to add the cachet of branding as a ‘Product of Jersey’ some interesting opportunities may become apparent.

The aims of this project are to undertake a primary scoping study to review the current position with regard to non-food crops and to discuss areas of interest with current end users and other industry stakeholders. The work will identify specific needs and / or opportunities in the non-food sector and link these with potential opportunities for crops in Jersey that could be taken forward in more a more detailed appraisal.

1.1.2 Project Methodology

Through a combination of existing knowledge, web-based research and discussions with industrial stakeholders, we have identified a vast range of novel crops options. The crops identified are primarily focussed on non-food opportunities, but there is some unavoidable cross-over into speciality food products. Furthermore, due to the main reason of this work being to address the PCN problem by extending the crop-rotation the focus is mostly on annual crops which can be integrated within existing arable rotations. A small number of perennial crop options have been considered, where particular indirect benefits are apparent – each will be explained in turn below.

² 1 vergées = 19,360 square feet (1,798.6 m²) = 0.444444 acres; 1 ha = 2.471 acres

Due to the problems with PCN this research has carefully considered a number of factors, to ensure new crop alternatives not only thrive on the island, but also improve the growing conditions for Jersey Royal production.

Being a small island, Jersey has limited land area and shipping costs are an important addition to production. Therefore, crops with high value and low volume outputs were prioritised. Islands are also typically reliant on significant imports of energy in the form of both fuel and food. Therefore crops which could improve sustainability and reduce reliance on imports were also considered.

Having an extensive coastline is a major factor to consider, as crops adjacent to the coast will suffer from salt spray and wind damage, and crops inland may also be subject to saline soils, with winds carrying the salt water. However, a number of crops have tolerance to salt and some even thrive in saline soils, and therefore would be well suited to growing on Jersey.

Protection of agricultural land using buffer crops such as evergreen salt tolerant trees and shrubs could be a possibility, to extend the range of crop options and to ensure greater productivity of niche inland crops. The coastline may also be exploited by the expansion of aquaculture.

Another major consideration is identifying crops which will complement potato production. Regular crop rotations bring many benefits, by improving soil fertility and reducing certain pests, disease, and weeds. It is extremely important to rotate crops from different plant families, as specific families are often targeted by the same pests and diseases, and have similar nutritional requirements. Potatoes are in the Solanaceae plant family; therefore break crops should not be from the Solanaceae family, as they would exacerbate the health problems faced currently. In particular, tomatoes are closely related to potato and suffer from the same nematode infestations (*Globodera rostochiensis*). Other Solanaceae crops to avoid include peppers, chilli and aubergine. In addition, certain crops increase potatoes susceptibility to blight, which should be avoided, including sunflowers, raspberries, pumpkins and squash.

Fortunately, there are a number of crops which complement potato production, by deterring pests and disease, such as marigolds, tansy, nasturtium, and asparagus. Other crops enhance potato flavour and growth, including beans, cabbage, and horseradish. Integrated pest management and good rotational practice, could be a vital tool in combating potato production decline in Jersey, where chemical alternatives are not performing.

In order to qualitatively assess each option for its suitability to Jersey and ability to address the challenges in question, a set of pre-defined criteria were developed; these included:

- **Climatic suitability** – based on published climate data for Jersey; incl. rainfall, daylight hours, average temperatures, max/min. temperatures and frost free days.

- **Market situation** – incl. level of maturity, scale of current market and future potential; also considered competitiveness against synthetic alternatives.
- **Value** – revenue potential for Jersey; incl. value of raw material, processing / manufacturing activities, and / or end product.
- **Branding opportunities** – potential for on-island processing, conversion or manufacture, to enable outputs to be branded 'Product of Jersey'.
- **Potential for local use** – considering the extent of tourism on Jersey and the resultant revenue potential or the possibility of displacing imports through local use.
- **Salt tolerance** – due to the location, climate and topography of Jersey, saline conditions are widespread, therefore a degree of salt tolerance would be favourable.
- **Addressing PCN issue** – ability to integrate within existing crop rotations on potato growing land, to break the PCN cycle or inhibit its spread.

2 Results

The following summarises the findings of our research, focussing primarily on non-food crop opportunities. However a limited number of speciality food crop options of notable interest have been included.

2.1 Medicinal Herbs

There is a large and growing demand worldwide for medicines from plants. Around 90% of plant medicines are still wild harvested, with a range of associated problems that impact on users' safety and the environment. New regulation for production and supply of mixed herbal extracts is in place and has created an opportunity for cultivation of endangered species in the UK, potentially. However, the introduction of the Traditional Herbal Medicines Directive in April 2011 meant unlicensed suppliers were no longer permitted on the market, and this reduced the scale of opportunity for local production.

Seventy percent of the 40-50,000 plant species used in herbal remedies worldwide are wild-crafted (20-30,000 tonnes pa from Europe, alone). 4,000 of these species are on the brink of extinction (WWF, 2004). 130 plant species are cultivated in Europe (between 70,000 and 100,000 ha), less than 500 species are cultivated world-wide.

Herbal medicines include raw herb (dried or fresh), tinctures (an infusion of herbs in alcohol), and extracts (solvent-extracted products). Herbal medicines are produced by direct extraction from whole plant material without further purification other than filtration. They generally contain a large number of constituents and active compounds possibly working in conjunction with each other, rather than a single, isolated active compound. Legislation has been introduced to control the sale of herbal products such as these; including Echinacea spp., Valerian and hops.

The range of plant materials used in herbal medicines includes all types of plant materials, including flowers, fruits, seeds, bark, gums exuded from trunks, roots and leaves. Generally traded material is dried and chopped/milled to some degree, usually by the producer.

The principal markets for medicinal herb raw materials are food and healthcare industries that manufacture:

- Dried herb products, incl. tablets and capsules
- Liquid extracts and tinctures
- Herbal teas
- Concentrated soft extracts (for further industrial application)
- Concentrated dry extracts (for further industrial application)

There are a number of key manufacturers in the UK, including:

- Seven Seas Ltd

- Neal’s Yard Remedies
- Boots plc
- Revital Ltd
- Brunel Healthcare (part of Elder Pharmaceuticals)
- Vifor Pharma UK Ltd (Potters Herbals)
- Ransom Naturals Ltd (part of William Ransom & Son)

Most of the manufacturers listed above were contacted as part of this research; although some were not able to discuss their supply chains or sourcing strategies, those whom were willing to engage in discussion provided some useful insight. In brief, discussions suggested the herbal extract industry continues to grow and is predicted to continue to grow, despite increasingly stringent regulations. Opportunities remain for the UK where provenance and local supply chains are important to manufacturers and suppliers, despite competition from India, China and EU countries. The smaller family-owned companies generally expressed the greatest interest in local supplies; however they stated that generally their sourcing strategies are influenced by their customers’ requirements, quality and price which can often restrict the opportunity for UK and EU suppliers.

Previous research led by NNFCC on UK medicinal crops concluded there are opportunities for R&D and production in the UK of between 14 and 36 species at least, highlighted due to the endangered, in-demand or suitability for production status. These include a large proportion of field-grown species, some of which may be suited to specific regions and others increasingly suited as a result of climate change. Specific crops showing strong potential, suited to UK conditions and cultivated in-field are summarised in the table below, further details can be found in the full report³.

Common name (Spp)	Plant part used	Growth habits	Demand / Potential
Bearberry (<i>Archostaphylos uva-ursi</i>)	Leaves, berries	Low-lying evergreen shrub. Prefers damp conditions	Limited potential, slow market growth. Competition from US.
Deadly nightshade (<i>Atropa Belladonna</i>)	Leaves, fresh/dried root	Perennial. Thrives in chalky soils. Leaves harvested in summer, roots in autumn.	Difficult to obtain; difficult to meet quality standards. Limited potential, slow market growth.
Wild indigo (<i>Baptisia tinctorum</i>)	Rhizome and root	Perennial herbaceous plant; grows to 3 metres. Needs good drainage.	Growing demand as immune system herb. Cultivation techniques require improvement.
Iceland moss	Whole	Yellow-green lichen, likes	Endangered medicinal plant –

³ Investigation into the Potential Market and Feasibility of Introducing New Medicinal Plant Crops into the UK and Europe, 2007 (<http://www.nnfcc.co.uk/tools/investigation-into-the-potential-market-and-feasibility-of-introducing-new-medicinal-plant-crops-into-the-uk-and-europe-nnfcc-07-015>)

<i>Cetraria islandica</i>	plant	alpine areas – not in-field.	strong market growth.
Hawthorn (<i>Crataegus oxyacantha</i>)	Dried flowers, berries	Deciduous thorny tree / shrub; grows to 8 metres tall.	Strong and growing market demand, high value. Further research on optimum varieties required.
Yellow Gentian (<i>Gentiana lutea</i>)	Fresh and dried root	Perennial herb; needs loamy soil and sheltered site – requires protection from windy conditions.	Top selling German prescription herbal; strong demand.
Goldenseal (<i>Hydrastis Canadensis</i>)	Rhizome	Herbaceous perennial	Demand strong and growing; supply limited.
Cowslip (<i>Primula veris</i>)	Flowers, leaves, root	Hairy perennial herb, growing 10-15cm only.	Low but growing demand.
Butcher's Broom (<i>Ruscus aculeatus</i>)	Aerial parts, rhizomes; collected when in fruit	Perennial shrub.	Relatively low, but growing demand.
White Soapwort (<i>Saponaria officinalis</i>)	Root, aerial parts	Perennial herb; gathered while in flower, roots gathered in autumn.	Medium demand; strong competition from overseas suppliers.
Baical Skullcap (<i>Scutellaria baicalensis</i>)	Root – from 3-4 year old plants	Perennial shrub.	Anti-nausea and AIDS treatment; growing demand.
Sweet Violet (<i>Viola odorata</i>)	Aerial parts	Perennial shrub; native to the UK.	Increasing demand for dried aerial parts; fragrance product.

To exploit current opportunities, seed must be sourced from reputable suppliers, of which there are a few in the UK (CN Seeds, National Herb Centre). A list of registered herbalists is available from the trade associations' website (www.associationofmasterherbalists.co.uk). Although the companies contacted above may be able to supply lists of the most in-demand herbs, a warning should be made that by the time a grower has sourced seed, grown and harvested the crop and got it ready for market – the list may have changed. It is therefore best to confine activities in the early years of production to traditional herbals – such as ***Echinacea, Valerian, Skullcap, St John's Wort, milk thistle, feverfew, etc.***

It is evident from the research that all of the species which are potentially suited to the growing conditions on Jersey have a perennial growth cycle, so although they may become an integral part of a larger opportunity in the future, their ability to address the PCN issue is limited and hence these opportunities will not be explored further at this stage.

2.2 Pharmaceutical Crops

In plant derived single molecule pharmaceuticals, 'bioactives' are extracted on a commercial scale by large multinational companies. Extraction and purification is very expensive due to the complexity of plant materials extracted via the primary extraction step. The production of phytochemicals from plant biomass is largely dominated in the UK by MacFarlan-Smith (Johnson Matthey Plc) in opiates (from poppies), with expertise and facilities also at Ineos Fluor.

Farm gate price is for crude biomass (dried), with the most expensive parts of the process still to be undertaken – extraction (circa £10/kg biomass) and purification (circa £1000/kg active). Production and processing costs for field-based crops could be circa £2,000/ha, depending on price of seed and nature of crop establishment (direct drilling or seedling), however protected and high security crops would be much higher (circa 10-fold). Crop yields typically vary from 1-5 dried tonnes/ha. Negotiations for contracts need to take all these issues on board, with commensurate prices/kg biomass being offered. Target figures for dry material ex-farm gate vary from £2/kg for field grown crops, and £10/kg for protected crops, but could also be 10-20 times higher than this in some cases, at least.

Crops destined for the pharmaceutical industry need to be maintained, often without access to pesticides and herbicides due to lack of approvals and potential for contamination with residues. This could be a problem in Jersey soils, if heavy pesticide use is required for crop survival, unless nematode resistant crops and varieties are selected. The crop must be harvested optimally for bioactive, washed (in some cases), dried, milled and stored/transported. Rigorous health and safety management will be required due to the complex chemistry in the raw material. Processing will require food-grade standards at the least and due to this complexity and the associated costs, is unlikely to be carried out in new extraction and processing facilities on Jersey. This opportunity is therefore likely to be limited to on-island cultivation, followed potentially by washing, drying and milling before being exported to the mainland for further processing and bioactive extraction.

Some examples of pharmaceutical crops that could be suitable for cultivation on Jersey are included below.

2.2.1 Daffodils

Daffodils produce a range of useful secondary metabolites, including Galanthamine, which is extracted from the bulbs and approved by the National Institute for Health and Clinical Excellence in the UK as a treatment of early stage and moderate Alzheimer's dementia.

Alzheimer's currently affects at least 600,000 people in the UK and as many as 35 million people worldwide, and incidences will increase dramatically as average life expectancies increase. There is large potential in the market since patents on Galanthamine, marketed as

Reminyl by pharmaceutical company Shire Pharmaceuticals, have recently expired and it is reportedly difficult to synthesise artificially.

Agroceutical Products in Brecon in mid-Wales are leading scientific work, discovering that chemical levels can be enhanced by certain stresses, and have developed highly specialised fertiliser treatments, unique harvesting and processing equipment. Daffodils grow well in the UK and European climates and some varieties show high levels of salt tolerance.

This could be a significant opportunity, but further research is required to determine the agronomic suitability to Jersey. Although daffodils are perennial plants, as Galanthamine is extracted from the bulb the whole plants are harvested, making this an annual crop when cultivated for this market. Involvement is likely to be limited to cultivation and drying prior to export. Land area requirements are likely to extend to 10's of hectares per year as opposed to hundreds or thousands and therefore overall value potential for the island is limited.

2.2.2 *Artemisia annua*

Artemisia annua, or sweet wormwood, is a shrub which contains the drug Artemisinin, which is used for anti-malarial combination therapy. Global demand rapidly outstripped production in 2004, leading to the World Health Organisation taking action to help farmers reduce costs and increase efficiency to ensure sufficient supply.

Sanofi created a synthetic alternative in 2013 using genetically-engineered yeast, costing £230-260 per kilogram, which is similar to the botanical source, and this may become cheaper in future. However, Sanofi currently only have the capacity to meet a third of the demand, equating to around 50-60 tonnes per year.

Artemisia is a fast growing annual, which thrives in sandy/loam, well drained, fertile soils, and in sunny temperate climates. *Artemisia annua* is extremely vigorous and essentially disease and pest free. However, it may not be suitable to grow on Jersey, as the growing season may not be long enough to accumulate high levels of Artemisinin.

Cultivation is in the relatively early stages in the UK and therefore further research would be required to more accurately determine suitability for cultivation on Jersey. Post-harvest options would also be limited, as *Artemisia* would likely need to be shipped fresh to the mainland, potentially incurring significant costs.

2.2.3 *Rosemary*

Market research indicates that there is a demand for rosemary extract as an antioxidant and the estimate of the worldwide value of the market was between £70-90 million in 2006. This market would require the production of 60,000 ha of rosemary assuming a price of £30/kg for 4% extract and a content of carnosic acid of 2.5%, 50kg/ha. The carnosic acid content of selected accessions grown in the UK is typically 4% and above, much higher than those

traditionally imported from Spain and North Africa which have carnosic acid concentrations of just 1%.

There are already a number of companies in Europe and the US extracting, marketing and using rosemary antioxidants in food, animal food, nutraceuticals and cosmetics. In addition there is a potentially large market for natural antioxidants in the plastics and biolubricants markets especially within food packaging and high value pharmaceutical plastics for prosthetics.

Rosemary is mildly salt tolerant and suited to the mild Jersey climate, but would need to be sheltered from the wind. However, Rosemary is a perennial herb and so would not integrate within typical annual crop rotations on Jersey and would not aid the issue with PCN persistence, unless a longer-term break crop was required to eliminate the issue on some of the more highly contaminated land.

2.2.4 Poppies

Poppies are grown commercially for the extraction of morphine and other valuable opiate drugs. Growing opium poppies requires a license from the UK government, and is illegal in many parts of the world including the USA and Germany, therefore limiting production but having large potential in global markets.

Poppies are a spring sown break crop and are well suited to the UK climate. They also have some tolerance to salt, growing in coastal areas, making them suitable for Jersey. Johnson Matthey Macfarlan Smith has ownership of the only UK poppy growing business, managing morphine supply from both UK and Portugal. Macfarlan Smith manages the agronomy as well as the harvesting of the crop, using specialist equipment. Growers are selected for their professionalism, location, soil type and their facilities including an on floor drying system, and are currently located in Dorset, Hampshire, Oxfordshire and Lincolnshire.

Having discussed opportunities for Jersey with Macfarlan Smith, they currently have no plans to expand production outside of the current growing areas on mainland UK, so this option will not be pursued; however if market dynamics and demand change in the future, it could be something to reconsider due to its climatic and agronomic compatibility.

2.3 Oleochemicals and novel oils

The largest application for oleochemicals, about 30% of market share for fatty acids and 55% for fatty alcohols, is for making soaps and detergents. Other applications of oleochemicals include the production of lubricants, solvents, biodiesel and bioplastics. Novel oils can also include those used in cosmetics, toiletries, healthcare products and even culinary applications for flavours, fragrances, dyes and nutritional benefits.

The cosmetics market in the UK is currently worth over £6 billion; a 3% market growth was reported in 2014. Plant derived oils and essential oils are used in cosmetics production but data is difficult to obtain from industry on volumes and market size. Similarly the market for natural healthcare products and food supplements, such as Omega -3 and -6 fatty acids, is expanding as health awareness improves and the population increases.

Natural oils are typically extracted in one of two ways; CO₂ extraction or cold pressing. The former requires highly specialised facilities; however the latter is a simpler option which can be carried out on relatively small-scales, whilst achieving good quality oil products. This option could be suitable for Jersey, where primary processing of relatively small-volumes of oilseeds is required prior to product manufacture. Cold-pressing is also suitable for batch-processing, so a range of oilseeds could be pressed through the same system in small batches, maximising the use and value of the equipment.

Subsequently oils could be exported for further processing and product manufacture, and potentially returned to Jersey and / or sold on mainland UK or more widely whilst still carrying the 'Product of Jersey' brand.

Refined oils require more complex processing but have odour and colour removed and have a longer shelf-life, of 24 months as opposed to 12-months. Refining is typically carried out in larger centralised facilities, due to the greater complexity and the higher cost of processing and handling equipment.

One particular company in the UK that focusses on production, processing and manufacture of speciality oil crops, oils and products is Statfold Seed Oils. They have been consulted as part of this research; they offer a multitude of opportunities for Jersey to consider, and further consultation should help to refine the list of opportunities and the benefits they may offer.

Statfold Seed Oils - Producer/Supplier of:

- Bulk Oils – globally sourced and supplied
- Essential Oils & Natural Fragrances – supplies over 200 oils, working with UK and global suppliers
- Nutritional Oils – grown and sourced in the UK/locally
- Extracts & Infused Oils – botanical extracts from flowers, leaves, bark, roots, fruit, berries, gums, whole plants and herbs
- Bulk Skin Care Bases – washes, gels, creams and lotions

Statfold Seed Oils - Services offered include:

- Contract Bottling – medium-sized and automated bottling and labelling facilities, to bottle small or large batches of oils or products.
- Cold Pressing – operating 20 cold pressing expellers with capacity to process 80 tonnes of seed per month
- Refining & Deodorising – ideal for high quality cosmetic grade oils
- Personal Care Manufacture – formulating and packaging products to suit unique brand requirements.

The following section summarises some of the key novel oil crops that meet some or all of the requirements for production on Jersey.

2.3.1 AhiFlower

The AhiFlower is an innovative crop, bred to have seeds rich in fish oils. Technology Crops International (TCI) developed the crop from *Buglossoides arvensis*, with seed oil exceptionally rich in plant-based source of omega-3 and omega-6 fatty acids, specifically, stearidonic acid (SDA) and gamma-linolenic acid (GLA). These are important nutrients for health, but mainly come from fish in the human diet, as they are naturally low in most plants, but overfishing and expense makes alternative sources an attractive lucrative market. *B. arvensis* is native to Europe, and can be annual or perennial, making it a suitable break crop.

AhiFlower is still becoming established in the UK, so suppliers and manufacturers are actively seeking growers. However, although mainland UK is the primary target, opportunities for wider sourcing may become apparent in the short- to medium-term.

2.3.2 Borage

Borage produces oil from the seed which is used in dietary supplements, baby foods, veterinary and personal care products. Borage seed oil is very high in gamma-linolenic acid (GLA) and valuable fatty acids, and is medicinally used to improve circulation and target blood disorders. It is also used to treat skin disorders such as Eczema, Rosacea, Atopic Dermatitis and Cradle Cap in infants; there is even an application pending for borage oil as a non-dairy creamer.

According to the UK's largest producer of Borage, it is the most profitable arable spring sown crop available, with opportunities to earn over £900 per hectare gross margin.

Borage uptakes salts from the ground, which gives the stems and leaves a salty flavour, which is good for remediating saline soils but can harm the plant if salt concentration is too high. It is also claimed to be a good companion plant, attracting bees and pollinators, and repels the tomato hornworm, leaving mulch high in potassium and calcium.

Borage is easy to grow, likes full to partial sun exposure, and grows well in Europe. This is a significant opportunity for Jersey, as growing conditions are highly suitable, it is an annual spring sown crop that would substitute potatoes in a rotation well and the market and product range is established; offering opportunities for local production, processing prior to export to the mainland for product formulation.

2.3.3 Evening Primrose

Evening Primrose is an annual or biennial (maturing over 14 -20 months) – its seeds are a rich source of gamma linolenic acid (GLA) which is used in health & nutritional supplements as well as cosmetics and skincare treatments. Yields are typically low (<1t/ha), although potential in optimum conditions is greater (2.5t/ha). It is a spring sown crop, but is sensitive to drought so requires rain after sowing to aid establishment.

Lowland areas are preferred and shelter is essential due to risk of seed loss at maturity. The crop requires warm, sunny conditions and dislikes shady areas – the north of the UK is unsuitable due to average annual temperatures being too low.

Historically significant areas of Evening Primrose were cultivated in the UK; however cheaper production in China, India and Asia caused production levels to fall in the late 90's. Opportunities still remain where local processing, manufacture, product branding and marketing is undertaken, making this an ideal opportunity for Jersey.

2.3.4 Camelina Oil (Gold of Pleasure)

Camelina Oil is cold-pressed from the seeds of the Brassicaceae annual plant *Camelina sativa*, also known as false flax or Gold of Pleasure. Camelina is mildly salt tolerant, so could be grown inland as a break crop. The oil content of the seed, on a dry weight basis, is typically between 30 and 40 percent.

Camelina oil can be used in both edible and industrial products. More recently camelina is being grown as a source of vegetable oil high in omega-3 fatty acids. The oil has been used successfully as an adjuvant in agricultural spraying applications, as a biodiesel, and it has been approved for use in cattle, chicken, and pig feed. Camelina meal, the product remaining after the oil has been extracted from the seed, is similar to soybean and canola meal and contains more than 40% protein and has a moderately-low glucosinolate content.

Camelina Oil is a very rich source of Polyunsaturated Fatty Acids (PUFA's) which makes it an excellent choice for nutraceutical use. Due to its high EFA (essential fatty acid) and linoleic acid content, Camelina Oil has very good effects on the skin, acting as an anti-age and emollient agent to improve skin elasticity and suppleness. Camelina Oil may be used in cosmetics, toiletries, soaps, pharmaceuticals, sun care and nutraceuticals.

Camelina seems to perform well as a companion crop and is considered a weed in many areas, due to its ability to survive in a diverse range of habitats, which enables it to be

introduced fairly easily into new environments. Camelina is often grown on marginal land and it responds well under drought stress conditions but may be better suited to low rainfall regions than most other oilseed crops. Camelina is highly sensitive to residual soil herbicides imidazolinones and sulfentrazone, so the field's history is important.

Camelina offers a significant opportunity for Jersey as a spring sown annual crop with proven benefits in personal care products. There would be an opportunity to extract the oil on-island and potentially export to the mainland for product formulation, branding and distribution.

2.3.5 Calendula (Pot Marigold)

Calendula is an annual (or perennial) companion plant which attracts pollen beetles and repels nematodes from the soil, which could be very beneficial to Jersey Royal production. Marigolds have some tolerance to salt, but would grow better inland.

Calendula, also known as Pot Marigold, has been an important medicine in folk healing in Ancient Greece, Rome and Arabia. Calendula preparations are used for treating e.g. minor wounds, callouses, eczema, itches, burns, insect bites and stings. The carotenes in Calendula promote the renewal of surface tissue and its antibacterial properties prevent infections. The power of Calendula has also been harnessed in beauty therapy, and it is used in lotions, creams and other cosmetics. Calendula has also been used to dye textiles yellow. The plant has many essential oils and so it has been used as an ingredient in perfumes.

Calendula leaves can be made into a pleasant tea or eaten in salads, and the flowers suit different kinds of food. It is also used as a substitute for saffron. Field marigold is quite common species in Central and South Europe.

Calendula, in a similar way to Camelina, offers significant opportunities for cultivation and primary processing on Jersey, with the added benefit of deterring nematodes.

2.3.6 Linseed/Flax

Linseed, also known as Flax, is a winter or spring sown annual crop. The crop is a rich source of Alpha-Linolenic Acid (ALA), omega-3 fatty acids and is widely grown on mainland UK and across Europe. Linseed oil or flax oil is widely used in healthcare supplements and personal care products. Flax is also grown for its fibre, which is used in composite manufacture due to its lightweight but high strength properties.

Linseed is easy to grow, with low input costs and a relatively short growing season meaning it integrates well into existing rotations as a spring-sown break crop and offers attractive returns. It is sown using conventional cereal or oilseed drilling equipment and harvested with a conventional combine harvester. The crop is either grown for its oil (linseed) or fibre (flax) but not both due to different varieties, agronomy and harvesting requirements.

The seeds harvested from linseed are tiny and overall yields are low, thus making this a viable option for production and export from Jersey to mainland UK for processing, extraction, formulation and product manufacture. Linseed can be cold-pressed, so primary processing could be undertaken on Jersey prior to shipping oil to the mainland for product formulation, manufacture and distribution.

2.3.7 Hemp

Hemp is a 4m tall, multifunctional, break crop, which produces fibre, oils, seeds, and valuable chemicals. Hemp fibre are six times as strong as cotton, and used to make paper, pulp, rope, cloth, furnishings, animal bedding, and building materials such as loft insulation and hempcrete, which has a lower carbon intensity than concrete.

Hemp oils are rich in omega-3 & -6 fatty acids, and are used in many applications including creams, cooking, plastics, and fuels. The seeds can also be eaten raw, and leaves used in teas. In some varieties, cannaboids can be extracted for use in multiple sclerosis treatment. In recent years breeding and selection has resulted in cultivars low in THC, the recreational drug, and hemp is once again being considered by governments as a useful crop. However, you need a Home Office licence to grow hemp in the UK.

Hemp grows fast, is very adaptable to soil and climatic conditions and is undemanding on resources such as artificial fertilisers and pesticides. It provides a good break crop for the farmer, giving the land a rest from other crops and helping to prevent disease. Hemp would be a useful crop to integrate into the existing rotation on Jersey, but it requires speciality harvesting equipment and would be a bulk product to export for processing as there is currently no small-scale equipment suitable for processing and fibre-extraction.

2.3.8 Sunflower

Sunflower oil is generally considered a premium oil because of its light colour, high level of unsaturated fatty acids and lack of linolenic acid, bland flavour and high smoke points. The primary fatty acids in the oil are oleic and linoleic (typically 90% unsaturated), with the remainder consisting of palmitic and stearic saturated fatty acids. The primary use is as a salad and cooking oil or in margarine but it is also commonly used in personal care products such as creams, gels, lotions and washes. Seeds are also widely used in foods, animal feeds and bird feed mixes.

Sunflower is an annual spring sown crop with a relatively short growing season, although seeds mature early harvest can sometimes be quite late in comparison to other oilseeds, as the seeds must be dry when collected. It is planted and harvested using conventional drilling and combining equipment. Although good drainage is required the crop is not drought tolerant and requires access to water at critical growth periods – it may require irrigation in drier climates. Sunflower has low tolerance to salt.

Although Sunflower suits the Jersey climate; the saline growing conditions and the scale of global competition make the opportunity for Jersey more challenging to exploit. This may form part of a wider package of speciality oilseeds cultivated on the island but is unlikely to be a major contributor. It is also known to increase potatoes susceptibility to blight and would therefore not be a good companion crop in rotation with Jersey Royal potatoes.

2.3.9 Bog Myrtle (*Myrica gale*)

Bog Myrtle, also known as *Myrica gale*, is a deciduous shrub native to north-west Europe, so could grow well on Jersey. Bog Myrtle is grown for its essential oils, dried bog myrtle, antibacterial and insect repellent properties. It thrives in Bogs, marshes, fens and wet heathland in acid soils but plants are occasionally found in calcareous fens. Although this is not suitable for addressing rotational issues experienced on Jersey, it could form part of an integral speciality oil product range.

There are around eight producers in the UK, including in south west England. Products are exported to Canada, Australia, USA, and within the UK.

2.3.10 Sea Buckthorn

Sea Buckthorn is a hardy drought and salt tolerant shrub, which produces orange 'superfruits'. The fruits contain oils rich in carotenes, omega 3 and 6, serotonin, vitamins A, B, C, and E, which are used for nutraceuticals health products and skin healing applications, such as facial cream and shampoo or for burns and eczema. The fruits are also sold as juice, oil, jam, carbonated and alcoholic beverages, toffees, biscuits, fruit chews, and nutritional ingredients. Leaves can also be used as tea. Many drugs have also been developed from sea buckthorn in Russia and China in different forms.

Sea buckthorn can control soil erosion and water loss effectively, and increase land reclamation in coastal areas. It would very suited to the climatic conditions of Jersey, and provide high value health products. However, as a shrub it is not a solution to the rotational issue but could form part of a wider package of speciality personal care products.

2.3.11 Samphire

Marsh Samphire is an increasingly popular health product which grows naturally in coastal areas, and loves saline conditions. It can be sold as a speciality vegetable which goes very well with fish and could complement Jerseys fishing industry, or used in high quality body and hand lotions, for its high levels of vitamin C and A, and minerals iron, calcium and magnesium which have antioxidant and regenerative actions on the skin.

Marsh samphire is currently used in high value UK brands such as Molton Brown and Noble Isle cosmetics and toiletries. Marsh samphire could be grown on Jersey's coastal areas, but the crop is unlikely to offer any benefit in terms of addressing PCN issues. Again, it could form part of a wider package of speciality outputs, but should not be a major future focus.

2.4 Speciality food crops

Although the focus of this project is specifically non-food crops, two specific speciality food opportunities with of particular interest were identified during this research. Although these opportunities may not address the Jersey Royal issue directly, they could be considered as part of a broader package of opportunities with potential for branding or local use on Jersey.

2.4.1 Truffles

Truffles are a very high value product and have great branding potential. Jersey's sunny, mild and wet climate makes it the only place suitable for Black Summer Truffle cultivation in the UK, and with droughts in the south of Europe causing yield decline, there is plenty of room in the market. Summer Truffles would also grow well on Jersey.

The UK market price for Black Truffles is currently ~ £1000 /kg and ~£400/kg for Summer Truffles. Damaged truffles can also be used for flavourings, oils, and value added to other products, including vodka and gin.

Mycorrhizal Systems who lead cultivation of summer and winter truffles in the UK provide plantation expertise, and guidance on harvesting, and can help with distribution if required.

Only 1-5 hectares of land would be needed and plantations can be made to look like natural forests, as truffles grow on the roots of trees including Hazel, Oak, Birch, and Quercus ilex (a salt tolerant evergreen suited to Jersey climate).

Preparation is the main work, only weeding is required for maintenance. Truffles are then harvested after 4 years using trained dogs to located them and humans to extract and clean them prior to them being shipped to the UK by courier for packaging and distribution.

Despite climatic conditions on Jersey being ideal, this opportunity would clearly not be suitable for production on existing arable land and would not directly address the current potato crop issue. However, the high value, low volume nature of production could add significant value to the Jersey crop industry, whilst offering opportunities for branding as a 'Product of Jersey'. There is also the potential for using damaged truffles as flavourings or for their truffle oil which could be used in cosmetics, skincare treatments and toiletries, for example.

2.4.2 Asparagus

Asparagus is a luxury health food, which thrives in salty conditions. Asparagus in the UK comes mostly from Peru, shipped in out of season. However, fresh British seasonal asparagus is highly sought after. Since asparagus often originates in maritime habitats, it thrives in soils that are too saline for normal weeds to grow.

Most importantly, Asparagus is said to be a useful companion plant for tomatoes and potatoes as it repels some harmful root nematodes so this could be a viable option for Jersey to consider, specifically addressing the current pest problem.

2.5 Salt tolerant trees and tall grasses

In order to protect the inland arable areas and to increase the range of crop options available for cultivation on Jersey, there are a number of suitable tree species, such as *Quercus ilex* (oak) and *Pinus nigra* (black pine), which could form a coastline buffer in the most exposed areas; however such species are likely to significantly change the landscape and result in the conversion of land from agricultural to forestry production which is likely an undesirable outcome for Jersey. Other salt tolerant grasses and woody biomass, such as *Miscanthus* and Willow, could be planted to offer a more temporary layer of protection; these crops would be harvested for bioenergy production, to improve sustainable heat and power generation on the island and to reduce fuel imports.

2.5.1 *Quercus ilex*

This salt tolerant evergreen oak tree would be ideal for sheltering crops further inland from salt spray and wind, having leaves all year round and being an attractive looking tree. It can be used in conjunction with truffle production, but the truffles may need to be grown further inland to limit salt exposure. The wood can be used in construction and furniture production for example and the acorns are edible.

2.5.2 *Miscanthus x giganteus*

Miscanthus is a 3 metre tall perennial bioenergy grass which grows well on salty soils, and could act as a buffer to salt spray and wind protecting crops further inland. The strong rhizome system deeply penetrates soil and can stabilise it, which prevents erosion and the crop is also used to regenerate damaged or contaminated soils. *Miscanthus* rhizomes are sown using potato planters, which Jersey already have the infrastructure for. It is generally harvested using a forage harvester, which may currently be present on Jersey, or alternatively a grass mower and baler could be used to cut and collect the biomass.

Once matured after 2-3 years *Miscanthus* is harvested annually, yielding around 10 – 12 tonnes per hectare. *Miscanthus* can be burned for heat and electricity production, so could make Jersey more energy independent, reducing energy imports onto the island.

2.5.3 Willow

Willow (*Salix* spp.) are fast growing moderately salt tolerant trees which are typically coppiced every three years. Willow trees could be used as a buffer to protect less salt and wind tolerant crops inland.

Aqueous extracts of the bark are said to have analgesic, antiseptic, astringent, anti-pyretic, and anti-inflammatory properties when ingested. The bark extract salicin is excellent for the skin, with antibacterial properties, aroma, and beta-hydroxy acid dry skin alleviation. This could be combined with some of the novel oil opportunities, to extend a skincare or cosmetics range carrying the Jersey brand. Furthermore the woody biomass is a good energy source; when harvested the trees are chipped and burned to generate heat and/or electricity – this could make Jersey more energy independent and less reliant on imports.

Willow typically yields around 25 – 30 tonnes of biomass when harvested every three years; averaging around 10 tonnes per year equivalent and the calorific value of the fuel is similar to or slightly higher than *Miscanthus*. Conventionally Willow is harvested using modified sugar cane harvesters, so this opportunity would only be successful on a small-scale on Jersey, avoiding the need to transport a harvester over, focussing on manual harvesting only.

2.6 Algae

Algae, including seaweed and microalgae, are used for an impressive range of high value products, including nutraceuticals, pharmaceuticals, cosmeceuticals, biopolymers, bioplastics, fermentation products, feed, oils, biofuels, hydrogen, and biogas. They do not compete for arable land or fresh water, and are widely considered as advanced feedstocks for biofuels and high value chemicals.

Growing seaweed could complement land production systems, using the material as a traditional fertiliser to enhance potato flavour, opening up new high value markets in seaweed extracts and oils, for cosmetics, toiletries, and skincare and healthcare products.

NNFCC are the pioneers and coordinators of the EnAlgae project, to facilitate collaboration between algae research and industry. The EnAlgae project could potentially link Jersey with algae scale up facilities, researchers or algae companies willing to invest or share expertise. The closest research partners to Jersey are Plymouth Marine Laboratory in SW England and the Centre d'Etude et de Valorisation des Algues in NW France who specialise in extracting algae proteins.

2.6.1 Seaweeds

Seaweed (macroalgae) can be grown on lines in seawater and therefore reducing pressure on freshwater sources. Seaweed is still used traditionally in Jersey Royal production for flavour by hand harvesting from the beach. If production was increased, valuable oils and chemicals could be extracted and sold, including alginate, and the remaining biomass used as a fertiliser. This would reduce any current dependence on imported fertiliser and create more high value products, while remaining with traditions.

2.6.2 Sea Oak Seaweed

Sea Oak (*Fucus vesiculosus*) is a form of kelp that has long been celebrated for its soothing effects on the skin, thanks to its abundance of minerals including iodine, calcium, magnesium and potassium. It can be used to make high quality hand lotion and hand wash. Sea Oak grown on lines in the sea would not compete with land crops, and does not require fresh water or fertilisers.

2.6.3 Microalgae

Microalgae (tiny sea plants) can be used to treat waste water and have applications in bioenergy and fuels, or can be grown in fresh water to produce higher value chemicals, pharmaceuticals, and cosmetics. This opportunity is more limited on Jersey and so has not been explored further.

Table 1: Results matrix, showing findings from qualitative analysis of opportunities

OVERALL RATING	Crop	Medicinal Herbs	Pharmaceutials	Oleochemicals & Novel Oils	Health & Wellbeing	Fibre	Energy	Specialty Food	Lifecycle	Climate	Market	Value	Branding	Local use	Salt tolerance	PCN Issue	TOTAL
●	Echinacea	✓	✗	✗	✓	✗	✗	✗	Perennial	3	3	4	1	1	2	1	● 15
●	Valerian	✓	✗	✗	✓	✗	✗	✗	Perennial	4	3	4	1	1	3	1	● 17
●	Skullcap	✓	✗	✗	✓	✗	✗	✗	Perennial	3	2	3	1	1	2	1	● 13
●	St Johns Wort	✓	✗	✗	✓	✗	✗	✗	Perennial	3	3	4	1	1	2	1	● 15
●	Milkthistle	✓	✗	✗	✓	✗	✗	✗	Perennial	4	3	3	1	1	2	1	● 15
●	Feverfew	✓	✗	✗	✓	✗	✗	✗	Perennial	3	2	3	1	1	3	1	● 14
●	Daffodil	✗	✓	✗	✗	✗	✗	✗	Annual	3	2	4	1	1	4	1	● 16
●	Artemisia annua	✗	✓	✗	✓	✗	✗	✗	Annual	2	4	4	1	1	3	3	● 18
●	Rosemary	✓	✓	✗	✓	✗	✗	✓	Perennial	4	3	4	4	2	3	2	● 22
●	Opium Poppy	✗	✓	✗	✗	✗	✗	✗	Annual	3	4	4	1	1	3	4	● 20
●	AhiFlower	✗	✗	✓	✓	✗	✗	✓	Annual	4	2	4	4	3	3	4	● 24
●	Borage	✗	✓	✓	✓	✗	✗	✓	Annual	4	4	4	4	2	3	4	● 25
●	Evening Primrose	✗	✓	✓	✓	✗	✗	✗	Annual	4	4	4	4	2	3	4	● 25
●	Camelina Sativa	✗	✓	✓	✓	✗	✗	✗	Annual	4	4	4	4	2	3	4	● 25
●	Calendula	✗	✗	✓	✓	✗	✗	✓	Annual	4	4	4	5	2	3	5	● 27
●	Flax	✗	✗	✓	✓	✓	✗	✓	Annual	4	5	3	4	2	4	3	● 25
●	Hemp	✗	✓	✗	✓	✓	✓	✓	Annual	4	3	3	4	4	3	4	● 25
●	Sunflower	✗	✗	✓	✓	✗	✓	✓	Annual	4	4	3	4	4	4	4	● 27
●	Bog Myrtle	✗	✓	✗	✓	✗	✗	✗	Perennial	4	4	4	4	2	3	1	● 22
●	Sea Buckthorn	✗	✗	✓	✓	✗	✗	✓	Perennial	4	3	4	3	2	4	1	● 21
●	Samphire	✗	✗	✗	✓	✗	✗	✓	Annual	3	3	3	3	3	4	3	● 22
●	Truffles	✗	✗	✗	✓	✗	✗	✓	Perennial	5	5	5	4	2	3	1	● 25
●	Asparagus	✗	✗	✗	✓	✗	✗	✓	Perennial	4	5	2	4	3	4	2	● 24
●	Miscanthus	✗	✗	✗	✗	✓	✓	✗	Perennial	4	5	2	2	5	5	1	● 24
●	Willow	✗	✗	✗	✓	✓	✓	✗	Perennial	4	5	2	2	5	5	1	● 24
●	Algae	✗	✓	✗	✓	✗	✓	✗	Annual	4	2	5	2	2	5	1	● 21

3 Conclusion

A vast number of opportunities have been explored for their potential on Jersey. To address the current pest problem in the potato industry and avoid the need for specialist planting and harvesting equipment whilst maximising value to the island, the greatest opportunity appears collectively in the novel oils sector.

In order for Jersey to benefit from these new opportunities and to retain as much value as possible for the island, the focus should be on high-value personal care products including cosmetics, toiletries and skincare treatments, such as creams, gels, lotions and washes. Such products would also lend themselves to branding as 'Product of Jersey' thus recognising the provenance of the material, increasing recognition and visitor numbers, and retaining as much value as possible for the islands economy.

A Jersey-branded personal care range comprising products made from and fragranced with Borage, Evening Primrose, Hemp, Camelina and Calendula for example could be an attractive proposition; offering opportunities for on-island sales to the tourism industry and potentially global sales, increasing the global recognition of Jersey as a raw material supplier.

A range of spring-sown annual novel oil crops could be cultivated as part of the existing crop rotation; spring sowing allows for land to be cleared of the previous crop and prepared for timely planting, and the typically short growing seasons of most novel oil crops lead to early autumn harvesting, allowing timely land preparation for the subsequent crop.

Most oil crops can be planted and harvested using conventional equipment; yielding low quantities of relatively high value outputs, meaning storage and transport requirements are simple and costs are kept low. There are also opportunities for primarily processing to be undertaken on-site or locally, using simple cold-pressing equipment to retain added value on the island. Small-scale equipment for this purpose is widely available and relatively cheap to purchase, install and operate – primary processing facility capable of pressing and filtering around 100kg per hour would cost less than £50k, with options to bottle, label and market cold-pressed oil for culinary use locally for an additional £30 – 50k (for bottling, capping and labelling equipment). Such equipment can be used on a range of oilseeds as opposed to a single seed type and is scalable from 10's to 100's of kilograms of seeds per hour. From this processing unit quality oil could be produced, which in low volumes could be shipped to mainland UK for further processing, formulation and product manufacture.

As illustrated in Table 1 crops suitable for cultivation on Jersey and of particular interest for this market include: AhiFlower, Borage, Evening Primrose, Camelina, Calendula and Hemp.

In order to establish a successful personal care products supply chain, the following stages would need to be considered:



Additional opportunities for Jersey, illustrated in Table 1 as having strong potential are bioenergy crops and specialty food crops. These options however do not directly fit within the purpose or scope of this project.

Bioenergy opportunities such as Miscanthus and SRC willow are perennial crops and are typically produced on non-prime arable land. There may be opportunities to remove small areas of land worst effected or at highest risk from PCN infestation, to cultivate perennial energy crops to generate renewable heat and / or power locally. As SRC Willow is a woody crop it requires specialist planting and harvesting equipment, unless grown on a very small-scale such that these operations could be undertaken manually. As stated in the results, SRC willow could also be cultivated towards coastal areas with a secondary purpose, as a moderately salt tolerant species, to protect inland crops from prevailing winds and salt spray.

Similarly, Miscanthus is a tall salt tolerant grass which could be used to protect inland crops with the resultant biomass being used for local heat generation. Miscanthus is planted using potato planters and harvested with grass mowers, so availability of suitable machinery is less of a concern; however the harvested material would likely need to be pelleted prior to being burned in suitable pellet boilers to generate heat.

Finally, speciality food crops are out of scope of this work; however during our research of salt tolerant crops suited to the Jersey climate, specific opportunities were identified in Asparagus and Truffles. Each opportunity is described in the main section of the report.

The opportunities are relatively widespread and several should be taken forward together as an integrated solution to the problems currently being experienced. There is a real opportunity to establish new crops and to develop an entire new product range from Jersey which would benefit the local economy, improve recognition and potentially attract more tourists, and if combined with bioenergy options identified could enable the island to become more self-sufficient in energy terms and less reliant on imports.

3.1 Recommendation for further work

In order to further validate the case for production of novel oil crops on Jersey, a more in-depth economic review is necessary. This would require commercial discussions with growers, contractors, processors, manufactures, equipment suppliers and retailers and a more detailed exploration of the scale and value of opportunity to Jersey.

4 Useful Contacts

The following is a list of organisations or resources that have been consulted as part of this research.

4.1 Technology Crops international

- Global speciality seed supplier and producer; focussing on speciality oil crop production
- Crops include: AhiFlower , Myrica gale, Camelina, Echium, Cuphea, Borage, Laboulet, Semences, Sunflowers
- Technology Crops Limited, Gowers Farm, Tumblers Green, Braintree, Essex, CM77 8AZ
- <http://www.techcrops.com/>

4.2 Premium Crops

- Leading UK speciality crop producer
- Crops include: Borage, Linseed, AhiFlower, Lupins, Millet, Red Wheat
- <http://www.premiumcrops.com/>

4.3 InCrops

- Innovation in crops, offering business support and commercialisation opportunities to SMEs in the alternative and non-food crops sector
- Specialising in: bio-based materials (flax, hemp), bio-based chemicals, bioenergy and fuels, algal biotechnology, sustainable agriculture, food health and well-being (e.g. sea buckthorn)
- <http://www.incropsproject.co.uk/>

4.4 EnAlgae

- EU INTERREG project to link algae producers and researchers, to facilitate scale up of innovative uses of algae.
- Many research and industry partners in North West Europe, including:
 - Plymouth Marine Laboratory
 - Centre d'Etude et de Valorisation des Algues in NW France
- <http://www.enalgae.eu/partners.htm>

4.5 Mycorrhizal Systems Ltd

- Tree plantations inoculated with truffle spores. Mycorrhizal Systems Ltd provides plantation services, expertise, and guidance on harvesting, and can help with distribution if required.
- <http://www.plantationsystems.com>

4.6 New Energy Farms

- Energy crop growers, including Miscanthus
- <http://www.newenergyfarms.com/>

4.7 Agroceutical Products Limited

- Daffodils - Scaling up galanthamine production with BEACON, based in Wales.
- <http://www.agroceutical.com/growers.html>

4.8 Statfold Seed Oils

- Stockist of 200 essential oils from natural extracts
- Major UK producer; offering a range of products and services of interest to this project
- <http://www.statfold-oils.co.uk/essential-oils>

4.9 NIAB Innovation Farm

- NIAB Innovation Farm is a pioneering knowledge transfer initiative supporting the translation on plant science discoveries into practical application; linking the science base and industry
- NIAB, Huntingdon Road, Cambridge, CB3 0LE, UK
- <https://www.innovationfarm.co.uk/>

4.10 Frontier Agriculture Ltd

- Frontier is the UK's leading crop inputs and grain marketing business, recognised for its close customer relationships with farmers and grain consumers and its successful management of the arable supply chain.
- Actively engaged in projects on Artemisia and Rosemary antioxidants
- <http://www.frontierag.co.uk/products-and-services/seed.aspx>

4.11 National Herb Centre

- Sourcing and supplying speciality herbs for medicinal, culinary and healthcare products
- <http://www.herbcentre.co.uk/>

4.12 Johnson Matthey Macfarlan Smith

- UK morphine poppy growing business
- Macfarlan Smith manages the agronomy of the crop as well as the harvesting of the crop, using specialist equipment. All crops are authorised by the home office.
- <http://www.macsmith.com/services/growing-morphine-poppies>

4.13 Crop Innovations

- Crop-Innovations is a charity in the UK, aiming to improve food security, nutritional status and the economic welfare of humans by promoting crop species that are currently not used to their full potential. Using a wider variety of crop species, that are able to grow in different climates or on marginal lands, creates more robust yields and farming communities better able to cope with climate change. Crop-Innovations partners agricultural development organisations to identify ways of maximising benefit from currently un-commercialised crops. Adapting scientific technology and methods to create devices and protocols that help farmers increase their yield and income.
- <http://crop-innovations.org/>

4.14 Molton Brown

- Made in England brand, using the finest natural extracts and essential oils for hair and body
- <http://www.moltonbrown.co.uk/>

4.15 Croda

- Speciality chemicals manufacturer and supplier
- Personal care, healthcare and industrial markets
- <http://www.croda.com/>

4.16 GW Pharmaceuticals

- Sourcing UK and EU grown hemp for Cannaboid drug development and manufacture
- <http://www.gwpharm.com/>

4.17 UK medicinal herbal product manufacturers

- Seven Seas Ltd - <http://www.seven-seas.com/>
- Neal's Yard Remedies - <http://www.nealsyardremedies.com/>
- Boots plc - <http://www.boots.com/>
- Revital Ltd - <https://www.revital.co.uk/>
- Brunel Healthcare (part of Elder Pharmaceuticals) - <http://www.brunelhealthcare.co.uk/>
- Potters Herbals (part of Vifor Pharma UK Ltd) - <http://www.pottersherbals.co.uk/>
- Ransom Naturals Ltd (part of William Ransom & Son) - <http://ransomnaturals.com/about>

NNFCC

NNFCC is a leading international consultancy with expertise on the conversion of biomass to bioenergy, biofuels and bio-based products.



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Non-Food Crop Options for Jersey (Part 2)

FINAL REPORT

Project Number: 17-003

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A report for States of Jersey Department of Environment

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Disclaimer

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1. Introduction

This report follows on from a report on Non-Food Crop Options for Jersey presented to the States of Jersey Department of Environment by NNFCC in March 2015 which concluded there existed a number of high-value non-food crop opportunities, to support or integrate with existing agricultural practices on the island.

The focus of the initial research was to review the position with regard to non-food crops and to identify specific needs and / or opportunities for crops in Jersey that could be taken forward at commercial scale. The greatest market opportunity was apparent in novel oils for manufacture of personal care products. Within this sector, six crop species were identified as being highly suitable in terms of climate, agronomy, market, branding and local use potential, these were:

- Hemp
- Calendula
- AhiFlower
- Evening Primrose
- Camelina
- Borage

Following interest from the agricultural sector on Jersey, this report was commissioned to provide further information on the six key priority options identified in the previous report plus two other options which offer commercial potential at scale. This report presents further commercial information, including the business case and specific market data, describing the likely value chain on Jersey, and providing actions and where available suitable contacts for follow-up.

Further information is also provided on processing options for novel oils with contact details for equipment suppliers and also contract manufacturers based in the UK who could formulate some high value products, which could carry the Jersey brand.

2. Commercial Crop Options

2.1 Hemp

2.1.1 Business Case

Hemp is a 4m tall, multifunctional crop, which produces fibre, oils, seeds, and valuable chemicals. Hemp conditions soil where it grows and is a good break crop. Hemp oils are rich in omega-3 & -6 fatty acids, and are used in many applications including cosmetic creams, cooking, plastics, and fuels. The seeds can also be eaten raw, and leaves used in teas. In some varieties, cannaboids can be extracted for use in medical preparations for multiple sclerosis treatment amongst others.

Hemp differs from the medicinal/recreational crop Marijuana, as hemp has low THC (0.3-0.5%) and the stalk and seeds are used for application, whereas Marijuana has 5-10% THC and the flower is utilised. In recent years breeding and selection has resulted in cultivars low in THC, the recreational drug, and hemp is once again being considered by governments as a useful crop. You need a Home Office licence to grow hemp in the UK.

2.1.2 Scale of opportunity

The global market for industrial hemp is estimated at \$600-800 million for hemp, \$10-120 billion for cannabis. European hemp cultivation is a niche, with 10-15,000 ha cultivated in the EU, mainly in France and previously Germany. In 2012 in the EU, 5,991 tonnes of hemp seeds / nuts were cultivated. In Europe the demand for Hemp seed is 12,000 metric tonnes per year, which is produced domestically (50%) and imported from China (50%).

There are only a small number of growers licensed to cultivate hemp in the UK, potentially due to added requirement to obtain a Home Office licence. In 2014 there were 7 licenses issued for hemp and 5 licences for High THC cannabis. To obtain a license, a company (not individual) must declare all sites growing hemp, pay £580, and not use cultivars of more than 0.2% THC. Jersey can create its own policy on growing hemp and issues its own licences, but is likely to follow similar policy to the UK.

2.1.3 Companies

In the UK, currently hemp is processed by GB Animal Bedding, previously Hemp Technologies and Hemcore (<http://www.hemptechbedding.com/home.html>), who also arrange licensing of the crop with the Home Office.

Companies who sell hemp oil for food include Good Hemp (www.goodhempfood.com) and Nutiva (<https://store.nutiva.com/cold-pressed-hemp-oil/>). Hemp oil producers for therapeutic oils include Naissance <https://www.enaissance.co.uk/organic-hemp-carrier->

[oil?search=hemp](#) and Ol'Vita <http://www.pure-oils.co.uk/en/hemp-seed-cannabis-oil/5-hemp-seed-cannabis-oil-cold-pressed-crude-olvita.html> and many seed companies including Suma, Sevenhills, Linwoods and Biona.

2.1.4 Value chain on Jersey

Hemp would be a suitable break crop for Jersey. Hemp is easy to grow, grows fast, is very adaptable to soil and climatic conditions and is undemanding on resources such as artificial fertilisers and pesticides. It is planted late April to early May and harvested August, grows 3 to 3.5m tall. It is retted in the field for 2-4 weeks and baled. The maturation of seeds is necessary for oil extraction, and new varieties (dual hemp) allow fibre and seed to be utilised optimally from the same crop. Due to the bulkiness of the crop, most hemp is grown on the east coast of England near processing facilities.

In order to extract the relevant components (i.e. seed, fibre, shiv) hemp requires speciality harvesting and processing equipment. The seed is typically collected at harvest, using a conventional combine harvester, leaving the straw in the field to 'rett' which facilitates separation of fibre from the stem during processing. In the absence of any on-island processors it would be a bulky product to export for processing in the UK or France. Small volumes have been grown in the East of England near processing facilities and in the South West where yields are better but transport costs are greater. Local processing facilities would improve returns. In the simplest form, hemp could be mowed, baled and then chopped for use in composites, bedding or building materials; however the individual and higher-value components could not be extracted using this method and the resultant market value would therefore be low.

In 2014 contracts for hemp were around £160 per tonne, delivered to the factory in October. Transport costs need to be taken into consideration, but could be around £15 per 50 miles, plus shipping and importation tax if sold back to the UK from Jersey. For conventional fibre hemp 7.5t/ha yield and £160/t delivered, the output would be £1200/ha, with £463 variable costs (seed £135/ha, fertiliser £195/ha, sprays £20/ha, haulage to factory £113/ha), and a gross margin of £737/ha. For dual hemp (seed and oil), 1-1.2 t/ha of seed is and straw yield slightly lower at 5-6 t/ha with price the same as conventional hemp. Seed contracts of around £500/tonne were in operation in 2014.

Hemp seeds could also be cold pressed on Jersey to produce high value oil, which is mainly sold as a cooking oil, and small amounts for cosmetics, nutritional supplements, and animal feed. Hemp seeds could also be sold to the local food market. Organic cultivation of hemp is mainly for the bio-food market. Cold-pressed hemp oil is sold in shops for around £1.50-£4 per 100 ml. Hemp seeds in the food market are sold for £6-30 per Kg.

For more details on growing instructions, please refer to the growing guide in Annex.

2.1.5 Actions

- Buy hemp seeds
- Plant seeds in late April to early May and harvest in August
- Cold press hemp oil from seeds on Jersey
- Sell hemp oil to local or export, food or therapeutics market. Or sell hemp seeds to local/export food market

2.2 Calendula

2.2.1 Business Case

Calendula officinalis (Pot Marigold) has a number of applications. It also a good companion crop for potato as it supresses eel-worm and has an attractive flower, which is good for public acceptance and can be made a feature for an established tourism industry.

Calendula dye can be extracted from flowers for colouring and flavouring food. The flowers are edible and also contain an essential oil which is used in natural remedies (e.g. for inflammation and wound treatment) and the cosmetics sector. The seed oil has applications in paints, coatings, personal care products and some industrial nylon products. The seeds contain 40-45% oil, 50-55% of which is highly conjugated calendic acid and 28-30% is the non-conjugated lieoleic acid (both C18:3).

2.2.2 Scale of opportunity

Calendula oil extracted from flowers is sold widely as a natural product to treat damaged or sunburnt skin. The skin care market is worth \$121 billion in 2016. Dry flower yields are up to 1.7 t/ha depending on variety, so only a small area could be tolerated on Jersey before the market became saturated. Flowers are typically harvested by hand as they bloom to retain quality and to protect the remaining plant.

Extraction processes separate calendic from linoenic acid which offers the opportunity of sale for different end uses.

Many companies sell calendula oil for skin care including Naissance, Nature Oils, Shealife, Weleda, Fushi Wellbeing, SALVIA, Vital Touch, Bio-Oil. Seed suppliers in the UK are generally for small scale cultivation, such as Just Seed, Heirloom & Perennial Ltd, , Haddons, Premier Seeds Direct, Midland Seed Company: Herb, PlantGenesis.

2.2.3 Value chain on Jersey

Calendula officinalis (Pot marigold) is a hardy biennial plant that is suitable for cultivation on Jersey with ample opportunity for oil to be extracted at a small scale extraction facility.

Calendula is spring sown (late March-April) and harvested in August-September using a conventional combine harvester to collect the seed. For more details on growing instructions, please refer to the growing guide in the Appendix.

Essential oil is produced by infusing petals in a carrier oil, which are left for four weeks in sunlight and then the petals are removed and drained. Oil extraction from the seeds is mechanical and is typically done using hexane extraction (see Section 3).

Calendula is an economically attractive crop but is heavily reliant on the market being strong and stable. Given the small quantities likely to be involved, extraction costs will be higher than for conventional oilseeds processed at scale, at £80-100 per tonne. For essential oil, there is just the cost for the carrier oil (preferably olive oil) and a clean glass vessel to infuse the petals. Calendula essential oil can be sold for £5 - £60 for 10 ml depending on dilution rates and its intended market. Flowers can also be sold to local restaurants and the food market, and to poultry farmers to deepen colour of eggs.

2.2.4 Actions

- Buy Calendula seeds, plant in April harvest in August/September
- Extract essential oil from petals or cold press oil from seed
- Sell essential oils to local/export market as skin care product, sell flowers to the local food market for salad/food dye/flavouring, or sell seed oil to paints/industrial market.

2.3 AhiFlower

2.3.1 Business Case

The AhiFlower is an innovative crop, bred to produce seeds rich in the nutritious oils omega-3 and omega-6 fatty acids (stearidonic acid and gamma-linolenic acid). These are important nutrients for health, but mainly come from fish in the human diet as they are naturally low in most plants; however, overfishing and high costs make alternative sources an attractive and lucrative market.

2.3.2 Scale of opportunity

The global market size for packaged omega-3 in food, drink and supplements has been estimated to be up to USD \$33 billion and growth is expected to continue, due to increasing demand for functional foods and supplements globally. The current market is restricted by availability of fish oils from sources such as anchovy, due to fishing regulations. This is where the vegan, renewable, non-GM alternative sourced from AhiFlower could allow the market to grow and flourish.

Nature's Crops International is the owner of the AhiFlower crop and processing facilities, and are key partners for this opportunity. Simon Meakin has been contacted to discuss production of AhiFlower on Jersey. At the moment Nature's Crops International have a fully subscribed Growers Club for Ahiflower, but there is a chance in future years as the area expands they would be looking for additional area and supply.

2.3.3 Value chain on Jersey

AhiFlower® Oil is made from the harvested seeds of proprietary cultivars of *Buglossoides arvensis* grown under exclusive contract with Nature's Crops by independent farmers in the UK, Canada and USA. The AhiFlower is suitable to be grown on Jersey as it is native to Europe, as a break crop or otherwise as it can be annual or perennial.

The crop is grown using standard arable combinable crop machinery, so would fit in on the island. The biggest concern would be seed transport, so contracts are normally a delivered to store price. Growers would also need drying and cleaning facilities suitable for small seeds.

The harvested seeds are then sent back to AhiFlower facilities to be pressed and extracted to achieve maximum oil yield. Seeds typically contain 20% oil. The resulting oil is refined and purified. Nature's Crops controls the entire process in its own processing facility, to ensure quality. Further information is available on the crop and products from <http://ahiflower.com>

2.3.4 Contacts

Simon Meakin - SMeakin@naturescrops.com UK Operations & Agronomy Manager, Nature's Crops International Limited.

General enquiries <http://ahiflower.com/contact/>.

2.3.5 Actions

- Obtain buy back contract from Nature's Crops International
- Plant AhiFlower in April and harvest in August
- Dry and clean the seeds for storage in on-island facilities, until required
- Ship to UK for further processing at centralised facilities

2.4 Evening Primrose

2.4.1 Business Case

Evening Primrose is a popular source of Gamma Linoleic Acid (GLA); the market of which is well established but highly volatile. Evening Primrose is grown under contract to supply GLA for nutritional products, cosmetics and pharmaceuticals.

2.4.2 Scale of opportunity

UK production is undermined by cheap imports from China. Contracts can be scarce and growing requires attention to detail for success, as yields are low and the mature crop is susceptible to losses if weather conditions are poor around the time of harvest. Evening Primrose is one of the least profitable of all oil seed crops considered, offering returns of around £290 per hectare. It has also grown out of fashion and been superseded by other technical oil crops, such as Borage which are targeting the same markets and similar applications.

2.4.3 Value chain on Jersey

For the local market on Jersey Evening Primrose could be harvested, cleaned and pressed on-island for use in toiletries and skincare treatments for example, and therefore may not have to compete with cheap imports.

2.5 Camelina

2.5.1 Business Case

Camelina sativa (Gold of Pleasure) has a valuable oil, exceptionally rich in omega-3 fatty acids (up to 45%). The oil also has applications in biofuel, lubricants and animal feed. With its high content of essential fatty acids and vitamin E content, Camelina oil has very good effects on the skin, hair, and health; for cosmetics, toiletries, soaps, pharmaceuticals, sun care and nutraceuticals.

2.5.2 Scale of opportunity

Camelina offers a good opportunity for Jersey as a spring sown annual crop with proven benefits in personal care products. It is mildly salt tolerant, native to Europe, and can be grown on marginal and land with less rainfall. Camelina is an emerging biofuel feedstock in the USA, which could offer another market if opportunities open up in Europe. In the UK there are currently no commercial scale producers, but current usage could support 1,000 ha. Yields are between 1 to 2.5 t/ha, and price is uncertain due to absence of domestic sector but indications suggest £250-300 per tonne can be achieved in optimum market conditions.

2.5.3 Value chain on Jersey

There would be an opportunity to extract the oil on-island and potentially export to the mainland for product formulation, branding and distribution. However, Camelina has faced issues in the UK market, with cost of production frequently reaching higher than the market will pay.

2.6 Borage

2.6.1 Business Case

Borage is indigenous to Britain and has been cultivated for centuries. It is principally sold as a dietary supplement, but also for cosmetics and pharmaceuticals, because Borage oil is high in gamma linolenic acid (GLA). Borage requires modifications to conventional agricultural equipment due to the sensitivity to seed shatter at harvest; an extended header and alternative cutting blade is essential and other modifications may be desirable. Borage should only be considered by those prepared to invest sufficient time in the crop husbandry, harvest and storage.

2.6.2 Scale of opportunity

Borage is the most widely grown specialty oilseed crop in the UK, but the market is saturated. The price of Borage is volatile, in the last three years the price has halved. Borage is a low yield/high risk crop with yields between almost nothing to 0.75 tonnes per hectare, with an average of 0.4 t/ha. Therefore one hectare of Borage can yield 400 Kg of grain (20% oil), which would produce 800 bottles of 100 ml borage oil, so a few hectares of Borage would quickly saturate the market on Jersey. More could be sold if exported. Contract prices for 2014 were around £3,500 per tonne, and growing prices are likely to be around £300-350 per ha.

2.7 High Erucic Acid Rape (HEAR)

2.7.1 Business Case

Oil from HEAR contains 50% Erucic Acid, a long chain fatty acid which has a number of industrial applications, including being a lubricant even at high temperatures – particularly in the petroleum and printing ink industries, and as a ‘slip agent’ in polyethylene plastic production that has a Generally Recognised As Safe (GRAS) to contact food status.

HEAR is the same plant species (*Brassica napus*) as conventional oilseed rape (OSR). However, erucic acid is considered harmful to human health, and has been bred out of OSR for human consumption which contains less than 2% erucic acid in the oil. HEAR varieties contain up to 50 - 55% erucic acid in the oil and are grown for industrial application only.

2.7.2 Scale of opportunity

HEAR attracts a premium over conventional varieties in the market place. The market for Erucic Acid is well-established and the demand globally is increasing, which provides an opportunity for expansion of HEAR production for 2017.

High Erucic Acid Rapeseed (HEAR) has been grown commercially for many years and contracts are available throughout the UK. Premium Crops can work with Jersey on a seed supply and buy back contract basis.

2.7.3 Value chain on Jersey

HEAR can be grown on Jersey, planting in September and harvesting in July. Planting and harvesting HEAR is very similar to spring-sown oil seed rape, the same equipment can be used. For more details on growing instructions, please refer to the growing guide in the Appendix.

HEAR is generally grown on buy-back contracts for central processing. Therefore HEAR is unlikely to retain value on Jersey past the farm-gate and transport, but the demand is large and market well established. Premium Crops buy back the seeds, which would need to be shipped to a processing facility on the Humber estuary. The most economical option would be to ship it directly to the Humber, rather than transport by road. Premium Crops suggest 4-5 thousand tonnes on a boat would be most economical, requiring around 1000 hectares, unless smaller amounts can be shipped on a shared unit.

With a yield potential of 3.2-5.0 t/ha and crop value of £92.50 - £145 per hectare. Assuming 3.5 t/ha yield the gross margin of HEAR would be £615 per hectare compared to double low oilseed rape's gross margin of £523 per hectare. For more information on the economics visit Premium Crops at <http://www.premiumcrops.com/hear/gross-margin.html>.

Alternatively HEAR could be grown in smaller volumes and cold pressed on the island to reduce shipping costs by exporting the oil rather than the seed. However, the processing and resultant oil quality would have to be discussed and approved by the end user or intermediary, such as Premium Crops beforehand. After the oil is extracted from the seed, erucic acid is converted in a chemical process to erucimide for commercial use.

A local market would be difficult to establish as it is a technical oil so processing for export would be the preferred option.

2.7.4 Actions

- Obtain contract from Premium crops or other seed supplier;
- Plant HEAR in September and harvest in July;
- Explore on island oil pressing if facilities could be established and shared with other oilseed crop options;
- Or ship to Hull to process at centralised facilities.

2.7.5 Contacts

Nigel Padbury - Premium Crops, Whitedale Farm, East Street, Hambledon, Hampshire, PO7 4RZ. Tel: 02392 632883/ 07816 412966 nigel.padbury@premiumcrops.com

2.8 Linseed

2.8.1 Business Case

Linseed is high in Omega 3 and can be sold directly to the animal feed market or oil can be extracted for the local or export market, for use in technical applications such as paints and varnishes.

Premium Crops International are market leaders for linseed and have buy back contracts available for 2017, with technical support for growers to maximise yields. Premium Crops sell the unprocessed linseed directly to northern France animal feed market. Jersey has the advantage of being closer to France than mainland UK and benefits from good trading arrangements with France and potentially reduced costs and therefore higher returns.

2.8.2 Scale of opportunity

There is large demand for linseed, so potential to grow tens or hundreds of hectares on Jersey. Linseed is a relatively minor crop in terms of production (only 1.5 - 2Mt produced globally) with few major suppliers. Until the last decade Canada was the major source, but GM contamination issues allowed Ukraine, Russia and Kazakhstan to become more active in the market. The linseed market has proved to be notoriously fickle but does not have speculative future pricing like OSR, so the advice is to secure a sensible price for an easily achievable quality. Prices are typically 10-30% higher than conventional oilseed rape (OSR).

An increasing market for linseed is for specialist animal feed, based on the naturally high Omega 3 content of the seeds. Premium Crops supply 55,000 tonnes of linseed each year to Valorex, a French animal feed company. Livestock fed on linseed-based feeds (known as "Tradilin" in France) produce meat and milk with improved Omega 3 content. However, most linseed has traditionally been crushed to produce technical oils for use in paints and varnishes, which offers an alternative and potentially higher value market compared to animal feed.

2.8.3 Value chain on Jersey

Linseed is an excellent break crop, sown in spring using conventional seed drilling equipment and harvested from late August through early September using a conventional combine harvester. It is a reliable, low risk crop and easy to grow. It can be grown with standard

machinery and on a large scale as there is large demand. For more details on growing instructions, please refer to the growing guide in the Appendix.

Extraction of linseed oil is not necessary if selling directly to the animal feed market. However, cold pressed linseed oil could be produced in small scale facilities on Jersey for the local and export market, targeting it as a technical oil in paints and varnishes.

The smallest practical area for planting linseed is around 10 to 15 hectares which would yield sufficient seed to warrant batch processing or transport for export. As the delivery charge to store is typically carried by the grower, the economics are highly sensitive to efficient transport and logistics. The grain could either be moved to Premium Crops mainland store in the UK or France, or to find a local store on Jersey may be the most practical option. The price achieved would reflect the cost of storage and shipping option chosen. The cost of bulk shipment and the final destination will depend on total quantity available. Anything above 5000 tonnes could be shipped in bulk and anything less than about 5000 tonnes (about 3000 hectares) would probably have to be moved by HGVs via road and ship.

The current harvest price for linseed is around £340 to £360 per tonne. An average spring linseed crop could currently be expected to yield in the region of £595 per hectare, making the gross margin around £360 per hectare. This is based on an average yield of 1.75t/ha and variable costs of £229 per hectare (comprising seed £80, fertiliser £85, and sprays £64).

2.8.4 Actions

- Obtain buy back contract from Premium Crops;
- Plant linseed in spring and harvest late August/early September;
- Store and primary process on Jersey, for technical markets; or
- Ship to French animal feed market, or other non-technical markets

2.8.5 Contacts

Nigel Padbury - Premium Crops, Whitedale Farm, East Street, Hambledon, Hampshire, PO7 4RZ. Tel: 02392 632883/ 07816 412966 nigel.padbury@premiumcrops.com

3. Oilseed Processing

Natural oils are typically extracted in one of two ways; solvent extraction or cold pressing. The former requires highly specialised facilities; however the latter is a simpler option which can be carried out on relatively small-scales, whilst achieving good quality oil products. This option could be suitable for Jersey, where primary processing of relatively small-volumes of oilseeds is required prior to product manufacture. Cold-pressing is also suitable for batch-processing, so a range of oilseeds could be pressed through the same system in small batches, maximising the use and value of the equipment.

Subsequently oils could be exported for further processing and product manufacture, and potentially returned to Jersey and / or sold on mainland UK or more widely whilst still carrying the 'Product of Jersey' brand.

Refined oils require more complex processing but have odour and colour removed and have a longer shelf-life, of 24 months as opposed to 12-months. Refining is typically carried out in larger centralised facilities, due to the greater complexity and the higher cost of processing and handling equipment.

3.1 Cold pressing

Cold pressing is the simplest method and is typically used to extract essential oils from citrus rinds and seeds. The oil recovery rate is relatively low compared to other methods, with typically 6% to 14% residual oil left in the cake.

Cold pressed oil is oil which has been produced with the use of a low heat technique. The introduction of heat to the process of making oil will degrade the flavour, nutritional value, and colour of the oil. Heat, however, increases the yield. For this reason, cold pressed oil tends to be more expensive, although it is also of higher quality.

The term "cold pressed oil" is subject to different regulations, depending on the part of the world in which it is made. In the European Union, for example, oil which is labelled as cold pressed must be produced in an environment which never exceeds a certain temperature. The temperature varies, depending on the oil, but is generally around 27 degrees Celsius (80 degrees Fahrenheit).

When oil is made, the nuts, seeds, or fruits being used to make the oil are first ground into an even paste. The paste goes through a malaxation process, a slow stirring which encourages the oil in the paste to clump. To extract the oil, pressure is applied, forcing the oil out of the paste. Heating the paste will increase the yield of oil. Some producers mix the paste with warm water, or heat it before pressing. Others make cold pressed oil by using an oil stone alone to remove the oil. After the oil has been produced, it is graded and bottled.

Some producers manufacture “expeller pressed oil” which is made in a high pressure environment. The high pressure is sometimes necessary with thick nuts and seeds, but it creates heat through friction. Some expeller pressed oil can be termed cold pressed, because the temperature does not rise a great deal. Other expeller pressed oil, however, is made at very high temperatures, and cannot be considered cold pressed oil. A producer must clarify by specifically labelling a product “expeller cold pressed oil.”

It is important to note that oils extracted using this method have a relatively short shelf life, so it is important to make only the market demands and can use within the next six months.

3.1.1 Equipment

Small-scale cold-pressing equipment is widely available and relatively cheap to purchase, install and operate – a primary processing facility capable of pressing and filtering around 100kg per hour would cost less than £50k and the cost of a cold-press suitable of processing up to 2 tonnes per day would be around £10k. Culinary grade filtering equipment may also be required (est. cost = £5 -10k).

Options to add equipment to bottle and label cold-pressed oil for culinary use or product formulation locally could be added; a facility to handle up to 600 bottles per hour would cost £10-30k depending on the degree of automation (for bottling, capping and labelling equipment).

Such equipment can be used on a range of oilseeds as opposed to a single seed type and is scalable from 10's to 100's of kilograms of seeds per hour. From this processing unit quality oil could be produced, which in low volumes could be shipped to mainland UK for further processing, formulation and product manufacture.

3.1.2 Equipment Suppliers

Yellow Fields Oil, Selby House Farm, Morpeth, Northumberland, NE65 8PR

- Email: info@yellowfieldsoil.com
- Website: <http://www.oilseedpress.co.uk>
- Kern Kraft oil presses that will press from 8kg to 500kg of seed per hour; oil filters; bottle fillers, cappers, labellers, pumps

Alvan Blanch, Chelworth, Malmesbury, Wiltshire SN16 9SG

- Email: info@alvanblanch.co.uk
- Website: <http://www.alvanblanchgroup.com>
- Suppliers of grinders, containerised oil presses (400kg/hr), filter press, seed cleaners and bottling equipment.

3.2 Extraction

Solvent extraction is a process which involves extracting oil from oil-bearing materials by treating it with a low boiler solvent (e.g. hexane) as opposed to extracting the oils by mechanical pressing methods. The solvent extraction method recovers almost all the oils and leaves behind only 0.5% to 0.7% residual oil in the raw material. Solvent extraction can be applied directly to any low oil content raw materials. It can also be used to extract pre-pressed oil cakes obtained from high oil content materials. Because of the high percentage of recovered oil, solvent extraction has become a more popular method of extraction of oils and fats, but due to the complexity it is more expensive.

Solvent extraction is basically a process of diffusion of a solvent into oil-bearing cells of the raw material resulting in a solution of the oil in solvent. Various solvents can be used for extraction and the choice will impact on or be influenced by commercial economics, edibility of the various products obtained from extraction, and physical properties of the solvent especially its low boiling point etc.

Focussing on hexane extraction, the process consists of treating the raw material with hexane and recovering the oil by distillation of the resulting solution of oil in hexane called miscella. Evaporation and condensation from the distillation of miscella recovers the hexane absorbed in the material. The hexane thus recovered is reused for extraction. The low boiling point of hexane (67°C / 152°F) and the high solubility of oils and fats in it are the properties exploited in the solvent extraction process.

The extraction process can be divided into the following stages.

1. Preparation of raw material
2. Process of extraction
3. Desolventization of extracted material
4. Distillation of miscella
5. Solvent recovery by absorption
6. Finishing and packing

Because of the highly inflammable character of the normal hexane, those stages of process which involve high speed machineries such as material preparation, finishing and packing should be carried out at least 50 feet away from the main extraction plant wherein the remaining processing stages involving handling of the solvent are carried out.

Using a similar method to above, the solvent can be substituted by carbon dioxide with identical equipment requirements which is a more scalable process and produces the purest extracts without the use of either heat or solvents. Supercritical carbon dioxide (CO₂) extraction is a relatively new process used for the extraction of aromatic products. The basic

concept is that CO₂ under pressure will turn from a gas into a liquid that can then be used as an inert liquid solvent. This liquid solvent is able to diffuse throughout the plant material thus extracting its aromatic constituents. CO₂ extracts contain most of the same constituents as their essential oil counterparts, although they can contain some elements not found in essential oils.

3.2.1 Useful contacts

Biorenewables Development Centre (BDC) -

<http://www.biorenewables.org/machine/supercritical-co2/>

Suprex Ltd - <http://www.suprex.uk>

Phytovation Ltd - http://www.phytovation.co.uk/default_e.htm

3.3 Distillation

Distillation converts the volatile liquid (the essential oils) into a vapor and then condenses the vapor back into a liquid. This method is more commonly used in essential oil extraction from plant material (as opposed to seeds) than any other extraction method. In addition to its popularity it is also the most cost effective.

Steam distillation is the most suitable separation process for materials that are temperature sensitive like essential oils. The traditional method of steam distillation is still used, whereby plant material is loaded into the extraction chamber and tightly compacted. As the boiler heats the water, steam is released into the bottom of the chamber and starts to travel upward, saturating the material.

The steam impregnates the plant fibre, causing it to release the oil molecule as a gas from the molecule pocked or channel. Then the steam carries the gas to the condenser where it goes through a phase-change condensation as it passes through the cooling process in the swan neck and liquefies into water and oil. The water and oil mixture then flows into the separator where the oil can rise to the top of the water to be poured off into containers.

In each of these processes as the steam rises, it carries the released oil vapor into the condenser where the water and oil vapor convert to a liquid and flow into the separator so that the oil can rise to the top of the water and be drained off.

There are many variables in steam distillation. Subtle differences in equipment design and processing conditions can translate into huge differences in essential oil quality. The size and material of the extraction chamber, the type of condenser and separator, and the temperature and pressure can all have a huge impact on the oil quality.

3.3.1 Useful contacts

Biorenewables Development Centre (BDC) -

<http://www.biorenewables.org/machine/distillation/>

The Essential Oil Company - <https://www.essentialoil.com/collections/distillation-equipment>

4. Contract Manufacturers

4.1 Skin/hair care

Cosmetics Laboratory Limited

- <http://www.cosmeticslab.co.uk/>
- Tel: 01403 261500
- Email: rc@cosmeticslab.co.uk
- Head Office, Horsham, West Sussex, RH12 3JR.
- Manufacture hair and skin care, no bottles or packaging; 500 units minimum order for 1 product

4.2 Soaps

Premier English Manufacturing Ltd

- <http://premier-emco.co.uk/>
- Tel: +44 (0)1244 390100
- Email: info@premier-emco.co.uk
- Minerva Avenue, Chester West Park, Chester, CH1 4QL, United Kingdom
- Specialise in the development and contract manufacturing of innovative and high quality soaps and personal care products

John Drury

- <http://www.john-drury.co.uk/contact-us/>
- sales@john-drury.co.uk
- Manufactures vegetable and tallow-derived soap-base noodles (including RSPO soap noodles) and flakes for customers to blend in their own products.

4.3 Supplements, vitamins, minerals

Bee Health Ltd

- <http://www.beehealth.com/manufacturing/>
- Tel: +44 (0)1262 607890
- Email: sales@beehealth.com
- Lancaster Road, Carnaby, Bridlington, East Yorkshire, YO15 3QY, UK
- One of the UK's leading vitamin, mineral and supplement manufacturers.

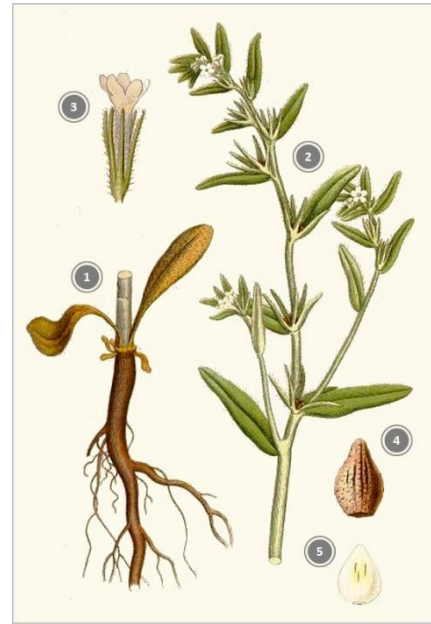
Appendix

1. AhiFlower growing guide

Buglossoides arvensis (also known as *Lithospermum arvense*, Field Gromwell, Corn Gromwell and Bastard Alkanet) is both annual and biennial in habit and is a member of the *Boraginaceae* family. The genus comprises approximately 18 species, including such well-known plants as borage, echium, comfrey, and forget-me-not. The plant is found throughout North America, Europe, and southeastern Australia.

Plant - *Buglossoides arvensis* grows to a height of approximately 24 inches (60 cm) with a spread of 6 inches (15 cm) across. The round stems are more or less hairy, and the alternate leaves grow up to 2 inches (5 cm) long and approximately 3/8 inch (1 cm) across. The *Buglossoides arvensis* root system consists of a taproot. *Buglossoides arvensis* has multiple flowering sites. Each flower is approximately 1/4 inch (7 mm) long. The blooming period typically occurs mid-spring to mid-summer and lasts about two months.

Seed and oil - Each flowering site of *Buglossoides arvensis* can produce four seeds, which are held tightly on the plant until harvest. The seed is approximately 1/8 inch (3-4 mm) in size, tetrahedral in shape, and has a greyish-brown surface that is rough and wrinkled. *Buglossoides arvensis* seed oil is a high, natural source of stearidonic acid (SDA). Oil content is typically 20%, of which approximately 20% is SDA, as well as other important essential fatty acids such as 42% alpha-linolenic acid (ALA), 11% linoleic acid (LA), and 5% gamma-linolenic acid (GLA).



For further information on growing AhiFlower, contact Nature's Crops International.

2. Hemp growing guide

Hemp (*Cannabis sativa*) is slender annual herb, with an erect habit growing up to 3 metres tall. Flowers are yellowish-green, leaves are located in clusters on a slender, angular stem. Stems and leaves are finely hairy and slightly toothed. Fruiting body is greyish-brown in colour and about 4mm long.

Potential Yield: 7.5t/ha, seed yield 2000kg/ha, oil yield 600kg/ha

Limitations: High drug hemp creates drug policing problems. Late harvesting of the crop makes dew retting unreliable and harvesting techniques are currently ineffective.

Soil Type: Rich, loamy soil containing plenty of humus and moisture. The soil should be well-drained yet moisture retentive. The minimum soil pH is 5.0, it does not grow well on acid or sandy soils.

Terrain: Lowland areas are preferred

Rainfall: Sufficient moisture is required, however hemp is sensitive to both water logging and drought. For fibre production it requires at least 670mm annually, although it will tolerate down to 300mm but will be relatively unproductive.

Temperature: The crop is frost sensitive. A sunny position is required for production. The crop shows good growth at low temperatures, however high temperatures late in the growing season hasten maturity. Emergence is limited by low temperatures in the spring. Annual average temperatures should be in the range of 6-27°C.

Sowing Date: Late April to early May, hemp for fibre should be drilled as early as possible to allow maximum stalk yield.

Harvest Date: Plants are harvested in August, and left to ret in the field for 2-4 weeks. Harvest time depends on application; for example for fibre applications harvest during early flowering, as stalk lignification increases after seeds are set. Whereas for oil seed application, mature seeds are needed to optimise oil yield and quality. However, current EU production rules insist that the crop cannot be cut until seed has been set. After harvest natural fibres have to be decorticated and the bast fibres baled. The core fibres are sold as animal bedding, bast fibres to industries such as non-woven materials and paper.

Fertility requirements: Initial requirements are 80-160kgN/ha, 80-120kgP/ha and 160-200kgK/ha. No further applications are required.

Weeds, Pest and Disease Control. No weed control is necessary as the crop will smother out infestation. It is so fast to mature it does not require any herbicides. Over 50 pests (viruses, bacteria, fungi and insects) are known to affect the hemp crop. However, hemp's rapid growth rate allow it to overcome the attack of most diseases and pests, and in most cases treatment of such diseases is neither practical more economical. Good agricultural practices can avoid pests, however pesticides can be used to tackle any pest problems such as mites, insects, and the hemp flea beetle. Birds may also affect germination and seed set.

Labour requirement. Cultivation of hemp requires 1.4 hours/ha ploughing, 1.3 hours/ha drilling, 0.4 hours/ha Fertilising, 0.2 hours/ha Spraying, 1 hours/ha Head stripping, 0.8 hours/ha Swathing, 1.25 hours/ha Bailing. This totals 635 man hours per 100 ha, or 0.32 man years. 3000ha of hemp would directly employ 10 people on farm and 7 in associated industries.

3. HEAR growing guide

HEAR is the same species as double low oil seed rape (*Brassica rapa*) and has the same growing requirements. HEAR is an annual (occasional biennial), ranging in height from 70-125cm depending on variety. Flowers are small and yellow. Stems are erect and branched. Seeds are small, dark and borne in narrow pods generally 4-6cm long.

Potential yield: 3.2 - 5.0 t/ha

Limitations: Rotational considerations may limit the potential of expanding the cropping area to a certain extent

Soil type: Well-drained, preferably alkaline solid, the crop prefers heavy land. Ideal conditions are a well-structured clay loam soil with a pH in the range of 6.5-7.0.

Terrain: Lowland area are preferred.

Rainfall: Moist conditions are preferred.

Temperature: Cooler conditions are preferred.

Sowing Date: For the winter crop, the last 10 days in August or the first 10 days in September. For the spring crop late March or early April.

Harvest Date: July for the winter crop. Mid-august to September for the spring sown crop.

Fertility requirements: Winter oilseed rape has high requirements for nitrogen, it can take up more than 250kg/ha annually although lower rates may be accepted. Spring oilseed rape requires much lower fertility inputs.

Weed, Pest and Disease Control: Many fungal diseases require control on the crop, as do the pollen beetle and aphids. Weeds need controlling, particularly those such as charlock which may contaminate the crop. Earlier sowing will reduce the need for treatment by ensuring the crop is well established and more resistant to attack or competition. On the other hand some problems are more likely to occur if the crop is sown early. Pigeons are a major pest to the crop, if not discouraged they may kill the plant. The extent of this damage is due to the fact that it is often the only green crop in an otherwise barren winter environment. Double '00' varieties may be more palatable to grazing pests such as pigeons, rabbits, and hares, and therefore susceptible to attack from such pests.

One problem on mainland UK is nicotinoid pesticide ban, which is affecting crop yields of brassicas. Could be less of a problem on Jersey if the pesticide is not banned, alternative measures can control pests, or a pest problem for brassicas has not developed.

4. Calendula growing guide

Calendula officinalis (Pot Marigold) is an annual (although could be perennial or biennial in southern Britain due to winter hardiness). The crop has multi-stemmed canopy, mid-green colour, flowers are yellow-orange and borne on branched stalks. Grows 50-75cm tall with a strong tap root. Stems are angular and covered in fine hair. Lower leaves of the plant are paddle shaped whilst upper leaves are smaller and more pointed. The seeds are grey or light brown in colour and vary in shape, decreasing in size towards the centre of the head.

Potential yield: Seed yields of 1-1.13t/ha on farm scale. Limited by seed shedding at harvest.

Soil Type: Light, easily warmed soils that are well-drained but have sufficient moisture. pH in the range of 4.5-8.3 can be tolerated.

Terrain: Lowland areas are best suited.

Temperature: Calendula is well adapted to the European climate, and is frost tolerant, but thrives in the sun.

Sowing date: Spring (late March-April)

Harvest Date: August to September

Fertility requirements: Maximum of 50kgN/ha is required (it is not responsive to higher rates), P+K may be required as maintenance dressings but again no more than 50kg/ha is recommended. In some cases excess fertility has resulted in lodging. Poor fertility can conversely result in poor uncompetitive plants and increased weed problems.

Pests, weeds, disease control: Weed control is important to reduce competition, ensure vigorous establishment and reduce harvesting difficulties. Mildew, botrytis and sclerotinia may need controlling. No known pests at present, although they are likely to develop as the area of production increases in future years. Calendula should not be grown in the same field on less than a six year rotation, also not as part of an intensive rotation with other susceptible crops such as sunflower and oilseed rape.

5. Linseed growing guide

Linseed Seed Rate

The standard seed rate for Linseed is circa 650 seeds/m² with the aim of establishing 400 plants/m², equating to 44 - 60 kg/hectare depending on the variety sown. However, if the crop is stressed in anyway (e.g. poor seed bed, herbicide damage etc.) the crops will often remain thin and yield can be compromised.

Soil Type/Rotation

Linseed suits most soil types and is not related to any other break crop, which means that it can easily slot into most rotations.

Linseed Sowing Date/Soil temperature

Linseed has a flexible sowing window, but is normally sown from mid-March through to mid-April. Soil temperatures need to be in the region of 6-8 Centigrade. Delaying drilling can have a positive effect on black grass control. Linseed is very flexible and can be established directly, minimally or conventionally to suit your system and soil types. Linseed needs to be drilled to 14 - 25mm depth into moisture, or deeper than 40mm if dry.

Linseed Fertiliser Rates

A low P & K requirement means that typical maintenance levels are only 30 - 40 kg/hectare of P & K. Nitrogen produces good responses on Linseed and should not be a limiting factor, typically 90-125 kg/hectare (75 -100 units/acre) depending on soil type.

Linseed Pesticides

To avoid yield loss, weed competition must be removed early, so spray broadleaved weeds when they are small, "Callisto" is recommended. For fungicide, Triazoles (eg Folicur) are cheap but give enhanced standing ability as well as disease control which allow crops to produce their full potential even in dry years.

Linseed Harvesting

Always desiccate Linseed for an early and easy harvest, Diquat or Glyphosate can be used. A well-managed Linseed crop should be ready for combining directly after completing the Wheat harvest – typically late August/early September, even if the stems are still green. Most combines handle linseed. Linseed will typically be harvested at 8.5% to 12% moisture, with the market standard being 9%. Linseed can be dried in any system that will handle OSR, with similar temperature settings. Do not dry linseed on-floor above a metre in depth, or in a bin system you will need to rotate with an empty bin. For a Protimeter conversion chart click [here](#).

Linseed straw can be disposed of either by chopping or by burning in the swath (it is exempt from the burning ban, unlike cereals). Linseed straw is ideal for on-farm straw burners. Linseed gives an ideal entry for wheat.

Linseed does not leave any N behind, but it does leave a friable seed bed that requires little or no additional cultivation. This gives a significant improvement in soil conditions compared to that following OSR.

For full and updated growing instructions visit Premium Crops website.

NNFCC

NNFCC is a leading international consultancy with expertise on the conversion of biomass to bioenergy, biofuels and bio-based products.



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Alternative Crop Options for Jersey (Part 3)

FINAL REPORT

Project Number: 17-003

December 2016

A report for States of Jersey Department of Environment

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Disclaimer

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1 Introduction

This report was commissioned by the States of Jersey Department of Environment following an earlier report, presented to Jersey by NNFCC in March 2015 which considered specific non-food crop options and concluded there existed a number of high-value non-food crop opportunities, to support or integrate with existing agricultural practices on the island.

The focus of the initial research was to review the position with regard to non-food crops and to identify specific needs and / or opportunities for crops in Jersey that could be taken forward at commercial scale. The greatest market opportunity was apparent in novel oils for manufacture of personal care products. Within this sector, six crop species were identified as being highly suitable in terms of climate, agronomy, market, branding and local use potential, these were:

- Hemp
- Calendula
- AhiFlower
- Evening Primrose
- Camelina
- Borage

Following interest from the agricultural sector on Jersey, a subsequent report was commissioned (Part 2) to provide further information on the priority options identified in the previous report, developing the business case and collating specific market data, describing the likely value chain on Jersey, and providing actions and suitable contacts for follow-up.

Following a period of continued interest from the agricultural industry on Jersey, the scope of this additional piece of work (Part 3) was defined to cover a broader range of crop options, not solely focussing on non-food markets but with a view to identifying niche and novel high-value opportunities for Jersey at the brink of commercial expansion, giving the agricultural sector on Jersey an opportunity to become a market leader.

This report presents the findings of this research; describing the nature, scale and value of each opportunity and considering the potential of each crop group for Jersey specifically. Contacts are provided where available, to enable follow-up.

2 Jersey Resource Assessment

2.1 Agricultural Resources

2.1.1 Land

The total area of land used for agriculture on the island of Jersey in 2014 was 34,411 vergées, which covers 53.3% of the land on the island (the total area of Jersey is 64,612 vergées)¹. The percentage of agricultural land farmed by the actual land owners was 21% meaning that 79% of agricultural land is rented.

Most of the holdings on Jersey are between 1-10 vergées in size (48%). The next most abundant holding size range is between 25 < 50 vergées (25%) followed by 50 < 75 vergées (9%). However, the majority of the smaller holdings do not claim Single Area Payments (SAP) and Quality Milk Payments (QMP) which serve as indicators of commercial agricultural activity. The area of agricultural land which is irrigated is 1,911 vergées.

In 2013 (as disaggregated statistics for 2014 are unavailable) the amount of land uncultivated was 1,831 vergées (5.2%). Owing to Jersey's small size and high demand for agricultural land, there is very little marginal land on the island. The marginal land that is present on the island is mainly cõtils or rough grazing for livestock. Cõtils are steep sloping fields that cannot easily be managed using farm machinery such as tractors, but are winch ploughed and hand dug at very high early returns. The marginal land used for grazing accommodates the heifers on the island and around 200 beef cattle.

2.1.2 Crops

The growth of potatoes dominates Jersey's vegetable productions with the area of land dedicated to all potato varieties in 2014 was 18,036 vergées (52% of total agricultural land). Of this land, 17,212 vergées were dedicated to Jersey Royals. Other vegetables grown outdoors include cabbage, top fruit and courgettes. The distribution of vegetables grown on agricultural land can be found in the Appendix.

2.1.3 Equipment

Most agricultural equipment is relatively small to cope with the associated infrastructure, which includes narrow roads and small fields. Conventional equipment for cereal, potato and grassland production is available.

¹ <http://www.gov.je/SiteCollectionDocuments/Government%20and%20administration/R%20-%202014%20Agricultural%20Stats%20DM%2028102015.pdf>

There are two modern combine harvesters on Jersey (+10 years old), one of which is owned by a local contractor.

2.1.4 Employment

In 2014, there were 1,582 agricultural workers during peak season on the island, the majority of which were seasonal or casual workers (59%). Full time workers comprised 32% of the farm labour work force, equating to just over 500 workers. Most agricultural workers are skilled in basic production of potatoes, cereals, grassland and livestock and the majority of the full-time workforce are capable of operating conventional agricultural equipment.

2.2 Glasshouses

The total area of glasshouses in 2014 was 225,470m². A breakdown of the age and some features of the current glasshouses are presented in Table 1. The majority of the glasshouse space on the island is over 15 years old (86%) with only 3% of the glasshouse area built in the last 5 years. Just under a quarter of the glasshouse space is heated and 11% of the space has not been cropped in the past 12 months.

Table 1 – Glasshouse area on the Island of Jersey, 2014².

	m ²	% of total glasshouse area
Glasshouses under 5 years	5800	3
Glasshouses 5-10 years	12	0.01
Glasshouses 10-15 years	26019	12
Glasshouses over 15 years	193639	86
Total Glasshouse area	225470	-
Heated area	50687	22
Not cropped in last 12 months	24150	11

Glasshouse production is often seasonal and typically used for extending growing seasons and overwintering higher value specialist crops, such as herbs, fruits or vegetables. Due to the nature of their use, glasshouse facilities often remain unused for significant periods and could provide an opportunity above and beyond the agricultural land described above.

² <http://www.gov.je/SiteCollectionDocuments/Government%20and%20administration/R%20-%202014%20Agricultural%20Stats%20DM%2028102015.pdf>

2.3 Exports

Potatoes comprised 94% of the total vegetable exports during 2014 (31,393 tonnes exported). Other outdoor grown vegetables exported from the island in 2014 included beans, cauliflower and courgettes.

2.4 Environmental Issues

2.4.1 Water Quality

The island of Jersey is reliant on its surface waters and groundwater (which is replenished from rainfall) for drinking, irrigation, industry and recreation³. As a result, any water quality issues may pose a threat to human health and the wider environment.

Jersey waters are susceptible to contamination from agricultural practises. High levels⁴ of nitrates are prevalent in some of the island's streams as a result of run-off and seepage into waterways from farms using nitrogen fertilisers³. Extensive use of pesticides (particularly herbicides) also pose a threat on the island as chemicals deriving from these sources have been detected in watercourses³. Jersey waters located close to areas where slurries are spread are also at risk of bacterial contamination.

2.4.2 Soil Quality

The majority of local soil on the island derives from extensive drift deposits of loess (Aeolian sediment), which have created a thick, rich layer of soil on which to farm. Some of the soil on the island derives from the underlying bedrock (these can mainly be found along the north-coast edge, north-west headland, south-west headlands and steep valley slopes). These soils are more acidic and thinner in their coverage in comparison to the loess deposits, and require irrigation where there are cultivated for farming.

As an island, Jersey soils may be susceptible to erosion from water or wind factors. Furthermore, with annual planting and harvesting of Jersey Royals, this may also contribute to erosion of soil from the potato fields. As the majority of farmland soils are glacial drift deposits, erosion is particularly problematic if prevalent.

³<https://www.gov.je/SiteCollectionDocuments/Industry%20and%20finance/R%20Condition%20of%20Jersey%27s%20Environment%2020050101%20SW.pdf>

⁴ above the maximum value of 50mg/L allowed by the Water (Jersey) Law 1972 (as amended))

3 Alternative crop options for Jersey

3.1 Crops to address potato cyst nematode (PCN) problem

With a prevalent PCN problem on the island, there are crop options such trap crops and biofumigant crops that can address the problem without the use of nematicides which as a result of changes to EU legislation are becoming more difficult to licence or obtain .

While these crops do not yield any financial rewards directly, their cultivation can firstly address the problem at hand without risk of adding any chemicals to the land which may reduce water quality issues and also result in improvement to soil following which potatoes or other crops can be grown thereafter.

3.1.1 Trap Crops: Sticky Nightshade (*Solanum sisymbriifolium*)

Solanum sisymbriifolium also known as Sticky Nightshade is a metre tall annual herb and a member of the Solanaceae family, the same as potatoes. The plant produces white flowers and later in life small, round red fruits which look like cherry tomatoes. Both the flowers and fruit are sticky to touch, which gives the plant its colloquial name.

It is a trap crop that can be grown on soil with a prevalent potato cyst nematode problem. The roots of the herb are similar to the potatoes however they are poisonous to the nematode. The sticky nightshade stimulates the PCN eggs to hatch however once the young nematodes try to feed on the plant's roots, they become poisoned and die. The result is that the potato cyst life-cycle is broken and potato crops can eventually be cropped successfully in this soil. Using trap crops can avoid or at least reduce the need for nematicides to be used which could reduce pressure around water quality. This method has been widely used in Jersey for nearly 10 years.

3.1.2 Biofumigant Crops

There are a number of biofumigant crops that can be used on the island, with brassicas a common type which address PCN issues and also improve skin finish and tuber quality. The crops function by releasing a chemical compound called glucosinolate (GSL) after planting which transform in to isothiocyanate (ITCs) in the soil. The ITCs then allow the potato cysts in the soil to hatch before killing the eggs contained within.

In order to liberate GSL from the biofumigant crops, they are grown to the mid flowering stage followed by macerating and incorporating the biomass in to the soil. The release of GSL and other enzymes from the plant cells produces ITC volatile gases after water has been added; therefore, water is essential for effective bio-fumigation.

Biofumigant crops which can effectively be used include Indian mustard and Oil Radish.

Potential for Jersey

Growing trap crops and biofumigant crops on the island of Jersey could help manage the PCN problem in combination with other proposed crop options. The growth of Indian mustard would also compliment the potato growing pattern on Jersey as the crops are planted in late summer/early autumn following potato harvest.

These crops however offer no additional value to Jersey, so although they present a potential solution to reduce the current problem, they do not offer alternative market opportunities and could not substitute Jersey Royals where production is no longer viable.

3.2 Food Crops

While the first piece of work conducted by the NNFCC for the State of Jersey focussed predominantly on non-food crop options, the scope for this second phase of work has been broadened to include investigating potential high-value, niche or novel food crops that can be grown. As a number of different food crops such as fruit and vegetables are already grown on Jersey, the experience of growing speciality food crops is already present. In addition, food crops grown on Jersey could supply local markets or benefit from the existing export infrastructure in instances where produce are supplied off the island.

While the market for some food crops may offer comparatively lower returns than the lucrative Jersey Royal (in addition to facing market saturation), there are a number of food crops on the brink of commercialisation that can be explored, which command high retail prices and compliment the direction in which consumer tastes and trends are heading. There is, at present time, a large consumer focus on healthy food products as well products with unique and different flavours. Furthermore, changes in consumer behaviour are apparent in which increased awareness of the health benefits of functional foods compliments an increased willingness of consumers to want to purchase products of a higher quality. The generation who are the driving force behind this consumer focus are the millennials group (aged 18-34 in 2015), who are currently the largest generation in the UK (and in the US).

The way in which consumers, in particular the millennials age category, are purchasing their groceries is also changing. Where 'weekly big shops' at large supermarket chains used to be the main method of grocery shopping, there has been a recent rise in consumers shopping in smaller supermarkets and inner city shops for their food. This increases potential for smaller food and farm businesses to introduce their products to these retailers where consumers can buy non mass-produced higher quality products. Furthermore, internet shopping continues to dominate all retail sectors where the correct marketing and SEO strategies can enable small businesses to run successful businesses online.

Considering the direction the market is heading, a number of potential food crop options are presented below. There is a particular focus on 'Obscure berries' for their superfood health market potential as well as gourmet food products.

3.2.1 Honeyberries (aka Haskap Berries)

Honeyberries are the seedless fruit of the perennial honeysuckle species *Lonicera caerulea* which is a thick upright bush. The honeyberry fruits look like an elongated or oblong version of a blueberry and taste like a cross between a raspberry, a blueberry and a blackberry with added 'zing'. Honeyberries are more acidic and flavoursome than blueberries which make them ideal for processing where they can be used to produce jams, jellies and sauces. Honeyberries are also high in anti-oxidants and vitamin C. Furthermore, a recent article⁵ revealed Innocent Drinks also expressing interest in this 'superberry'.

Honeyberries are a relatively new fruit to the market however their health benefits, vibrant colours and similarity to other berries could make their integration easier. Market trends have shown that one of the key categories where millennials are spending more money is in the fresh fruit and vegetables market (37%).

Growing Honeyberries

Honeyberries are considered a cold climate plant which is planted in autumn. As hermaphrodite plants, more than two cultivars should be planted (in equal amounts), with four to six cultivars per acre recommended depending on orchard size to obtain a high fruit yield. Honeyberries can be planted as 'semi-dormant' plants in prepared orchard plots (in rows) and 50cm apart from each other in the rows to allow wind and insects to pollinate. Honeyberries are extremely winter hardy and require around 1000 hours of 'chilling' (dormancy) over the winter months when all of the plant's energy is diverted to root growth. Spring *orchard* planting should be avoided as it disturbs and retards early growth and conditions can often be too wet for establishment, to avoid the young shoots rotting.

Other methods of planting honeyberries include planting young plug (5cm) plants in the spring in 3-11 litres pots, growing them through the season and planting a larger plant in late September-early October. This maximises early growth and eliminates weeding requirements in the critical first growing year. Depending on the honeyberry variety, the berry will ripen between June and July. Honeyberries are easy to detach from the pedicel and can be harvested both manually or with a berry-picking combine. Honeyberry yields per acre are between 8,000-12,000 pounds (from 1,000 plants per acre).

⁵ <http://www.producebusinessuk.com/supply/stories/2016/03/02/why-honeyberries-could-be-the-next-soft-fruit-to-conquer-the-produce-aisle>

Potential for Jersey

As a new berry, there is potential for Jersey to position themselves as a key producer and front runner in the honeyberry market. The plant is already being investigated by the Plant Health Laboratory and forms the first 'Alternative Crop' trial to be planted in Jersey under the new Rural Economy Strategy 2017.

With increasing consumer focus on healthy superfoods and exploring new flavours and tastes, the potential for honeyberries is significant. As honeyberries can be harvested by hand, in the initial stages of a honeyberry orchard this method of berry collection could be used primarily while the orchard becomes fully established. As fruit and vegetables are currently exported off the island, the infrastructure is already in place which honeyberry growers could make use of. Furthermore, as honeyberries can be used as an ingredient in other products (e.g. honeyberry gin) the potential to penetrate different market sectors either on- or off-island is possible. Integration with other on-island enterprises, such as drinks and other food industries who could utilise honeyberries as a novel ingredient or flavouring offers great potential.

Honeyberries could be sold to island retailers and businesses on a small scale or exported to the UK and EU on larger scales. As punnet fruits such as strawberries are currently exported from the island, the infrastructure is currently in place which would help facilitate this. As a unique berry, it provides an excellent marketing opportunity to brand honeyberries as a product of Jersey. As a new berry, global supply is low and thus attracts premium pricing from £3.50 to £6.50 per kg. Frozen berries can attract a higher price of £5 to £8 per kg.

Growing honeyberries on Jersey could utilise the glasshouse or polytunnels during initial growth stage in pots before transfer to outdoor fields.

Useful contacts

- A full growing guide for honeyberries can be purchased from <http://www.lovehoneyberry.com/>
- Arbuckle's, Scotland's first honeyberry farm - <http://www.arbuckles.co.uk/>

3.2.2 Aronia Berries

Aronia berries, also known as Choke berries, are dark round juicy berries which derive from the hardy Aronia shrub. Aronia berries can be used in a wide range of products including juices, jams, jellies, cakes, desserts, yoghurts, ice creams and smoothies. They can be readily frozen, dried, powdered, and chocolate covered or candied. Aronia berries are considered a health product owing to the berries anthocyanin, antioxidant and polyphenol contents amongst others. Commercial uses include medicinal remedies, natural food colouring, health

and well-being nutritional supplements, natural cosmetics and diabetic energy foods. It is also used as a food colourant in Haribo sweets. It is not necessarily considered a punnet fruit due to its zesty flavour however it can be used in all applications listed above.

Regarding medical use specifically, Aronia berries and products are also sometimes consumed by pancreatic cancer patients undergoing chemotherapy as laboratory tests have shown that Aronia can halt the growth of cancer cells⁶. As a food ingredient it can be found in several popular food and drink products.

Similar to honeyberries, the Aronia berry market is still in its infancy due primarily to the fact that people are unaware of the berry's existence. The only large Aronia berry plantation in the UK's primary export is Aronia juice and the business operates exclusively online (www.aroniaberriesuk.co.uk).

The greatest potential market for Aronia berries is at local markets and online while the berry's familiarity is still in infancy. It could also be supplied to high-end restaurants and caterers who can utilise it as an ingredient and flavouring in many common dishes.

Growing Aronia Berries

Aronia berries prefer neutral to slightly acidic well drained soils located in full sun. Irrigation may be required however as the Aronia shrub is not very drought tolerant. Bare-rooted seedlings are planted in spring after the threat of frost has passed although containerised Aronia can be planted in to mid-summer as long as adequate moisture is available.

For Aronia, labour requirements are estimated at 120 - 150 hours to establish one hectare. To produce 8 tonnes using a mechanical harvester, annual labour equates to 15-25 hours for production, 65 hours for harvest and 65 hours for packing. Hand harvest of Aronia berries requires around 1 hour for every 7.5 kilograms harvested.

In the UK, the single largest Aronia berry plantation was established from cuttings from Eastern Poland at a cost of around £1.30 each. Growth from cuttings to full size berry bush will take about three years. Once established, Aronia plants will yield an average 4,000 berries/plant. Although they can be hand harvested, as the berries weigh around 1g each, picking large amounts may be inefficient. One hectare will accommodate around 1,800-2,000 shrubs.

⁶ <http://www.nhs.uk/news/2014/09September/Pages/Berries-boosts-chemo-for-pancreatic-cancer.aspx>

Potential for Jersey

Growing Aronia Berries on Jersey would complement the growth of other superberries mentioned above, where a Jersey superfood health value chain could be established.

Useful contacts

Andrew Tickle (UK Aronia Berry Farmer): <http://www.aroniaberriesuk.co.uk>

3.2.3 Sea Buckthorn Berries (Sea Berries)

Sea Buckthorn berries, or Sea Berries as they are otherwise known, are a small orange-red round to oblong fruit rich in omega oils, vitamins A-E and K and Carotenoids and Flavonoids. The berries can be used in the culinary, healthcare and cosmetic sectors. For example, one culinary use is to extract the juice from the berry which can be consumed neat, sweetened or blended in combination with other fruits in smoothies, nectars and cordials. Oils, which can be extracted from the pulp or seed, are rich in essential fatty acids which have applications in skincare or general health products. The oils and other fruit extracts have been used in traditional Chinese medicine for centuries.

The Sea Buckthorn market, similar to the Haskap and Aronia berries, is a relatively new market in the UK as consumers lack awareness of the berry. Retailing of the berry has in the past few years been largely on-line or in specialised health shops. Awareness is increasing however as the berry and other superfoods have become 'on-trend'.

In the UK, there are currently only four Sea Buckthorn plantations producing at large-scales. Estimations or worldwide production reveal that China is the biggest producer of Sea Berries (est. 600,000 ha) followed by Russia (est. 2,000 ha). The UK currently has around 15 ha of Sea Berries growing. Sea Berries require adequate soil nutrients for a high yield of good quality fruit and respond well to phosphorus fertilisers.

Growing Sea Buckthorn Berries

In the UK, berry yields range from 5-10 tonnes/ha. At present time, labour intensive harvesting procedures can often represent between 50-75% of the overall growing costs owing to lack of development in effective harvesting methods - as the sea buckthorn is not a 'true berry' there is no abscission point on the fruit making the Sea Berries cling onto the peduncle and not separate easily. The window for harvest is around a fortnight in the early summer and hand harvesting is slow (~1-2kg/person per hour). Other methods of harvest include vacuum harvesting or placing a tarp under the bush and beating with a stick.

Potential for Jersey

The potential for Sea Buckthorn berries on Jersey is similar to honeyberries and Aronia berries, whereby the establishment of a superberry value chain could be established.

3.2.4 Goji Berries

Goji berries (or wolfberries) are the red fruit of a hardy, perennial deciduous shrub (*Lycium barbarum*) which have risen in popularity in recent years. The berries produced can be eaten fresh, cooked or dried and are considered a superfood due to their vitamin C, B2 and A content in addition to their iron, selenium and antioxidants contents. The Goji berry plants hardiness derives from its toleration, once established, of wind, salt-laden air and drought. As a result, goji berries could be grown on a variety of land areas on Jersey, including the coastal regions.

No large-scale goji berry plantations are currently established in the UK. In reviewing various goji berry products (dried berries, extract) currently on sale in the UK, most of them are grown in China.

Potential for Jersey

Unlike the Honeyberries, Aronia berries and Sea Buckthorn Berries, there appears to be greater awareness of goji berries as some goji berry products (in particular dried berries) are currently on sale in the UK. As goji berries in the UK are sourced from abroad, there is potential for Jersey to establish a high-quality, locally-produced goji berry which could be dried and sold on island or exported.

3.2.5 Garlic

Garlic belongs to the genus *Allium* and is native to central Asia. Used mainly in culinary applications, garlic is a popular ingredient in dishes worldwide. China is the largest single garlic producing country in the world (accounting for around 42% of production in 2012) where around 20,000,000 tonnes of garlic are produced annually. China and the United States are the largest suppliers of garlic while North America have the largest demand (47%). Europe has a 17% share in global garlic demand.

Garlic is only produced on small scales in the UK however some relatively large garlic plantations are emerging. These include the largest UK producers, the South-West Garlic Farm in Dorchester (13 acres) who sell to restaurants, farm-shops and delicatessens as well as big outlets in Bristol and London. The farm also produces speciality 'black garlic' which is considered a superfood and has been awarded two-stars at the Great Taste Awards 2014. Other larger-scale producers in the UK include the Garlic Farm on the Isle of Wight where garlic has been grown for the past 50 years. The Garlic Farm sells a range of garlic and garlic

based products (e.g. butters, oils, sauces, hampers and gifts) at their farm shop on the island and online at premium prices.

Growing Garlic

Garlic and 'Gourmet garlic'⁷ are easy crops to grow and have the benefit of taking up very little space during growing. There are over 600 varieties of garlic, some of which are very adaptive, having the ability to withstand very cold winters. Regarding taste, gourmet garlics have unique flavours which make them popular with chefs.

Garlic crops are propagated from cloves which can be purchased or saved from a previous harvest (once a garlic farm is established). Replanting 'held-back' bulbs has the added benefit of allowing farmers to continue to grow the varieties that work best in their microclimate as well as being free of disease. Another method of growing garlic for free is to save and plant the bulbils⁸ although this process is variety dependent. Although this method will take 2-5 years to obtain full size bulbs, a high yield will be produced.

Garlic grows best in fertile, well-drained loamy soil and depending on the variety, are planted at various times of the year: in the UK, some varieties are planted during Autumn (October and November) and harvested in summer while others can be planted in spring and harvested late summer, allowing farmers greater flexible for spreading labour throughout the year. Garlic grows best in sunny areas which are well drained and contain alkaline soils- garlics do not thrive in acidic soils and so lime application may be required if soils are acidic.

Potential for Jersey

The garlic market is very well established with imports from abroad the main source garlic consumed in the UK. This opens up opportunity for high-end, domestically grown garlic which compliments the direction of consumer tastes and preferences for high-quality, rich-flavoured products. On Jersey, autumn planted garlic could be planted on farmland or under polytunnels as an alternative to potatoes as their growing and harvest cycles are matched, providing a break in potato growth and extending the rotation. Furthermore, spring planted varieties could be planted following a potato crop and harvested in late summer. Following harvest, garlic could be used on the island, for sale to restaurants and other catering outlets as well as through farmer's markets where high-end local produce could be marketed in similar manner to the Garlic Farm products. Garlic could also be exported off the island for mainland UK retail.

⁷ Some gourmet garlic varieties include Rocambole, Porcelain and Purple Stripe with each having their own unique flavour, taste, and uses

⁸ Small, secondary cloves found scape of hardneck garlics, or along the false stem of softnecks.

Useful contacts

Marshalls Seeds: <http://www.marshalls-seeds.co.uk/how-to-grow-garlic-ggid102.html>

The Garlic Farm: <http://www.thegarlicfarm.co.uk/growing/tips-and-advice>

Garlic World: <http://www.garlicworld.co.uk/grower/page5.html>

3.2.6 Gourmet/Speciality Mushrooms

Global mushroom production is dominated by China who are the world's largest producer (~48%) followed by the EU who are the second largest producers (~29%). As mushrooms are a perishable item however, the global movement of mushrooms is somewhat limited to 'neighbouring' countries.

The highest valued mushrooms are 'Gourmet or Speciality mushrooms' which include the oyster, shiitake and portobello varieties. Associated with fine dining, gourmet mushrooms command the highest retail prices and thus produce high returns per area grown. Although mushrooms can be eaten fresh or dried, gourmet mushrooms are mostly grown for fresh-market sales and as a result, their production is mainly performed by small operators who tend to focus on local markets. Nevertheless, in their dried form, the consumer can re-hydrate the mushrooms (using water or wine) creating a much more flavoursome mushroom than the original whilst also prolonging its shelf-life.

Growing Mushrooms

Growing mushrooms first involves investing in spawn which is the fungus tissue used to propagate mushrooms. Spawn comes in various forms such as grain mixes, sawdust and in wooden dowels called plugs. To grow mushrooms from the spawn, a suitable substrate is required. A common substrate is an inoculated⁹ (removal of all types of fungi) hardwood log. Other substrates can include paperback books (less than ten years old) and toilet rolls.

The spawn has to be introduced to the substrate, following which it should be kept somewhere cool, out of the sun and wind as mycelium begins to form. Following this, the mushrooms will begin to grow and require very little input beyond the introductory stage.

Potential for Jersey

As gourmet mushrooms are mainly grown for fresh supply, there is potential for establishing mushroom production on Jersey to supply local upmarket restaurants on a very regular basis. Furthermore, freshly grown mushrooms could be sold at farmers markets and via other

⁹ Wood inoculation can be performed via heat treatment (with water or steam) or even microwaving

retail outlets on the island. In terms of export to the UK and other nearby European countries, this is also possible for freshly grown mushrooms. As shiitake and oyster mushrooms are the most well-known of the speciality variety and they are consequently the easiest to market and therefore immediate options for Jersey. However, other less-known varieties are growing in popularity enabling Jersey to begin production of emerging speciality varieties.

Although mainly sold fresh, gourmet mushrooms can also be sold or exported in their dried form provided drying facilities are available as dried mushrooms are much less bulky (7kg of fresh mushrooms yields 1kg of dried mushrooms). Dried gourmet mushrooms are also a great gift idea and packets of dried mushrooms could be sold to tourists as a holidays gifts, or marketed off-island as "produce of Jersey".

3.3 Herbs and Plants

Herbs and plants can be grown for a wide range of applications including culinary, health-related and medical applications. With an increase in consumer's focus on health foods, selecting to grow herbs and plants for this market segment offers real opportunities. Selecting to grow herbs and plants that can be sold into a various markets as a variety of products also maximises the potential rates of return.

In part one of the work which NNFCC carried out investigating non-food crops for States of Jersey, a number of medicinal herbs were highlighted as potential crops which could be grown. It was outlined in part one of the project that during the early years of production of medicinal herbs, it is recommended to confine activities to traditional herbs instead of the herbs that are currently 'in demand' as by the time a grower has sourced seed, grown and harvested the crops ready for market, the market conditions may have changed. Nevertheless, growing medicinal herbs can be very lucrative as an array of products can be produced from them and the herbal medicines market is reportedly increasing.

In this second part, the list has been expanded with a focus on herbs and plants that can be used for medicinal purposes but also in the health foods sector- in line with the change in consumer trends outlined in Section 2.2 and the broader scope of this follow-on research.

3.3.1 Tea plants (*Camellia sinensis*)

Camellia sinensis is the evergreen bush from which fresh tea leaves are produced and can be processed to make up to 300 types of white, black and green tea. The bush is native to China and Southeast Asia however is now cultivated across the world in subtropical and tropical regions. Despite dominance of tea-growing in these regions, *Camellia sinensis* can be grown in temperate climates.

Tea is the world's second most consumed beverage (after bottled water) with a retail value of 43.1 billion US dollars in 2014. In Western Europe, the UK is the greatest tea consumer with a share of around 63%, with black tea being the preferred variety. Black tea is also the main variety consumed in Poland, Belgium, the Netherlands and Denmark while Portugal, France, Germany and Austria prefer fruit and herbal teas. Although black tea is the current tea of choice in the UK, consumption of black tea is actually declining having fallen 6% over the past five years while the green and herbal fruit tea markets are increasing as consumers (predominantly the millennials) are seeking newer alternatives to traditional products.

The speciality market for 'high-end' teas is also increasing. In 2012, Starbucks acquired the speciality tea and accessory retailer 'Teavana' for \$620 million. The company has 400 locations across the Americas and the Middle East. Furthermore, although the black tea market is decreasing in the UK, globally the white tea market is increasing with China, who are a large tea producing and white tea drinking nation, now being net importers of white tea.

As mentioned above, *Camellia sinensis* can be grown in temperate climates. The UK's first tea plantation was set up in the Highlands of Scotland in 2011 as 'The Wee Tea Plantation'. Since then, a UK alliance has been formed under 'The Scottish Tea Growers Association' banner, and currently includes around 15 tea growers from all over the UK, with a target of 28 gardens by the end of spring 2017. Currently, 4 gardens are producing tea for market which is sold under 'The Wee Tea Company' brand. Of the producer gardens, the tea plants are sold out for the next four years and have included a whole range of customers, domestically and abroad including Nicola Sturgeon, First Minister of Scotland and the Queen.

Growing *Camellia sinensis*

Camellia sinensis can be purchased as seeds for cultivation and or as young plants. *Camellia sinensis* seeds are sown in the spring (where evening temperatures are >12°C) and require acidic soils and lots of water for growth. The seeds are best planted in pots indoors with lots of sunlight following which they will sprout in four to six weeks. Seedlings should then be planted in a partially shaded spot in sandy slightly acidic soils of pH 5-6 (which may suit them to the headland and coast soils). It is important to note that from the seed, *Camellia* plants can take up to three years to begin production however the plants can live for up to 70 years. Table 2 shows the cost of *Camellia sinensis* plants from Plants4Presents:

Table 2 – The cost of *Camellia Sinensis* plants in 1L and delivery to Jersey from Plants 4 Presents (as of September 2016)

	Cost 10+	Cost 100+	Cost 500+	Cost 1000+
<i>Camellia Sinensis</i> in 1L Pot	£15.00	£8.50	£7.50	£6.40
Delivery to Jersey	£12.00	TBC	TBC	TBC

Different tea varieties require different degrees of processing. Producing white or green tea is a simple process. The tea leaves are harvested in spring and summer following which they are steamed (using a steamer or placing the leaves in a colander over boiling water for two minutes). The leaves wilt following which they doused in cold water. The leaves are then rolled in to cigar shapes and then oven-dried at 100°C for 10-12 minutes, turning them half-way through. These fresh leaves can be used to make tea or further dried to make the leaves very dry and crispy for storage and future use. The seeds of *Camellia sinensis* can also be pressed to yield a sweet seasoning or cooking oil.

Potential for Jersey

Tea drinking culture is evolving to a position where fruit and herbal teas are on trend and set to increase. Furthermore, consumers are gravitating towards high-end quality tea products. As a result, there is potential for tea to be grown on the island where a small-scale plantation could produce high quality green and herbal tea products which is where the market is headed. Also, combining tea production with some of the berries described at 3.2 could deliver a niche range of novel fruit teas unique to Jersey.

In terms of growing *Camellia sinensis* on the island, the glasshouses on Jersey could be used for the initial growth of the plants before transfer to fields.

The current president of the Scottish Tea Growers Association explained when contacted during this research that tea plants would grow very well on the island of Jersey and he would be happy to discuss potential opportunities.

Useful contacts

The Wee Tea Plantation: <http://www.weeteaplantation.com/>

The Wee Tea Company: <http://weeteacompany.com/>

Plymouth Tea – A member of the Scottish Tea Growers Association:
<https://www.plymouthtea.co.uk/>

Plants4Presents (<https://plants4presents.co.uk/>) have previously supplied tea plants to the 'Wee Tea Plantation'.

Teavana: <http://www.teavana.com/us/en/home>

3.3.2 Chamomile

Chamomile is a perennial plant belonging to the Asteraceae family and is one of the oldest and widely used medicinal plants in the world. The flowers of the chamomile plant can be

used to produce a variety of products with reported medicinal properties such as anti-inflammatory, antispasmodic and sedative properties amongst others. Chamomile flowers can also be dried and used in teas or ingested as a herb, or used as a source of essential oil which can be used in aromatherapy applications as well in toiletries and soaps.

The chamomile market is very well established. Teapigs, who are a high-end tea retailer, highlighted a current big focus on chamomile tea. Furthermore, Chamomile Strong Infusion is a product listed in Ransom Naturals top 20 selling products - a leading developer and manufacturer of natural products.

Growing Chamomile

Chamomile seeds are sown in spring/early summer and grow best in sunny environments with well-drained soil (however, they will tolerate some degree of shade). Seeds can be planted in shallow pots and then transferred outdoors after the last frost. Chamomile does not require a lot of fertiliser and unless the soil is very poor, fertilisers will not be required throughout the season. Flowers will bloom throughout the summer (June-August) and so there is no specific harvest time. Harvesting chamomile requires accuracy as it is only the flowers and not the stems that is required, so on small areas this is typically done by hand.

Average yields for chamomile are around 20-25t/ha for fresh flowers. The average oil yield per hectare is around 750kg.

Potential for Jersey

The potential for growing chamomile on Jersey is significant owing to the different market sectors chamomile penetrates. If tea-growing is established on the island, growing chamomile could compliment this, creating a large tea enterprise. Furthermore, chamomile grown on the island could also be used to extract essential oils, further diversifying the market for this crop and complimenting the part one recommendations which focussed on novel oils and applications.

Useful contacts

Ransom Naturals (developer and manufacturer of natural products and extracts to the Pharmaceutical, Healthcare, Cosmetic and Food & Drinks industries):

<http://ransomnaturals.com/>

Cottage Chamomile (Chamomile Essential Oil Producer in the UK who produce oils on farm using steam distillation): <http://cottagechamomile.co.uk/>

Teapigs: <https://www.teapigs.co.uk>

3.3.3 Hibiscus

Hibiscus is a flowering plant belonging to mallow family Malvaceae. The primary products of hibiscus are the fresh flowers, while the secondary products include dried and frozen hibiscus, juice and wine, sauces and syrups, tea and herbal medicines. Teapigs also referenced hibiscus as a key ingredient in the current herbal tea market.

China and Thailand currently dominate world hibiscus production while the highest quality hibiscus is currently grown in Sudan. The United States and Germany are the world's largest importers. Although production is dominated in the far-east, there are opportunities to penetrate the hibiscus market with better quality products and reliable production - the quality of the hibiscus from China is sometimes not up to standard owing to less stringent quality assurance measures.

Despite the potential for market penetration, the global hibiscus market is very volatile and prices can fluctuate dramatically. This is due to the fact the flowers grows easily in many places which can result in oversupply, having the knock-on effect of lowering prices, resulting in farmers switching crops which lowers supply the following year and causes prices to rise again.

Growing Hibiscus

Hibiscus is quite hardy and grows in most well drained soils. It can tolerate poor soil and requires 4-8 months with night-time temperatures above 21°C. Furthermore, it requires 13 hours of sunlight per day during the first 4-5 months of growth. Hibiscus also requires 5-10 inches of rainfall in the first 3-4 months of growth so irrigation is not uncommon.

Potential for Jersey

Penetration into the mass hibiscus market is unlikely owing to the scales of production that could be achieved on Jersey. However, there is potential for establishing hibiscus on the island of Jersey with a focus on locally sourced, high-quality products which can be distinguished from poorer quality imports. If cultivated for use in tea products, this would complement growing of Camellia and other plants and herbs grown for tea applications, establishing Jersey as a key UK tea producer.

3.3.4 Elderflower/Elderberry

Elderberries and Elderflowers both derive from the elder plant (*Sambucus nigra*), which is a herbaceous perennial. The flowers of the elder plant blossom before the fruit and so are harvested at different times in the year. Dried elderflower has also been used as a traditional herbal medicine for many years. Furthermore, elderflowers can be used for their flavour and

are commonly used as a drinks ingredient. Elderberries have a distinct fruity flavour and is a popular flavouring in alcoholic beverages such as cider. Most commercially grown elderberries are sold to processors for wine, juices, jams, syrups and pies although there is increased interest in elderberries in the health tonic industry.

Ransom Naturals, who are leading developer and manufacturer of natural products, rank 'Elderberry Strong Infusion' and 'Elderflower Strong Infusion' in their top 20 top selling extracts.

Similar to chamomile, the elderberry and elderflower markets are much more established and they can be found in a number of products currently on sale in the UK market including elderflower essence and cordial and elderberry extract.

Growing Elderflower/Elderberries

Sambucas nigra grow well in a variety of different soil types although moderately fertile soils with adequate surface and internal water drainage are best for commercial production. The plants grow best at pH 5.5 – 6.5 with moderate phosphorus levels and relatively high potassium demand. The Elder plant produces its flowers in late spring and berries in late summer/early autumn, with elderberry coming in to full production after 3-4 years. Under good growing conditions around 7.5 - 10 tonnes of fruit per hectare can be achieved.

Production costs for an irrigated small scale (1 hectare) elderberry plantation are estimated at £1,000 per hectare. Harvesting and marketing costs are around £1,800 per hectare with total expenses (variable and fixed) estimated at £2,400 per hectare.

Potential for Jersey

As a dual product plant, growing elder plants on Jersey could result in two value chains from one production cycle. As elderberries and elderflowers are key ingredients in the health foods markets, the elder plant on Jersey could be used to produce a host of health foods which could be sold on island as well exported. Owing to Jersey's small size and relatively small scales of production, the opportunity for upmarket products with a focus on small, local production could be capitalised upon.

Useful contacts

Ransom Naturals (developer and manufacturer of natural products and extracts to the Pharmaceutical, Healthcare, Cosmetic and Food & Drinks industries):

<http://ransomnaturals.com/>

Elderflower Farm in Lincolnshire: <https://www.belvoirfruitfarms.co.uk/elderflower/>

3.3.5 Lavender

Lavender is a genus of 39 known species belonging to the family Lamiaceae. Lavender has a unique aroma and is used to produce a number of products from its petals. These include dried lavender flowers, essential oils and natural body products including lotions and washes. Lavender can also be used to produce specialist lavender foods which includes biscuits, preserves and honey. The lavender market is very established in the UK, with several farms producing lavender on large scales. Details of some of the UK's lavender farms are listed below.

Growing Lavender

Lavender grows best in warm sunny climates. It is very difficult to grow from seed and so purchasing as seedlings or taking cuttings from existing plants represents the easiest way to grow lavender. Lavender is planted in spring (between April and May) and thrives in any poor or moderately fertile, free-draining soils. Lavender is ideal for chalky alkaline soils. Pruning of lavender is necessary however feeding is minimal, although potash will help flowers bloom. Lavender is harvested during August-October where yield of around 1.5-4 tonnes/ha can be achieved.

Potential for Jersey

While lavender could be grown on Jersey for the production of dried flowers, essential oils and body products, as there are currently a number of lavender plantations in the UK, the niche for local-produced, high-end lavender products is already filled. Nevertheless, the number of plantations signifies a market for lavender and lavender products and an opportunity to develop local products as "Produce of Jersey" is evident, generating marketable for the on-island retail and tourist industries.

Useful contacts

Mayfield Lavender: <http://www.mayfieldlavender.com/>

Somerset Lavender: <http://www.somersetlavender.com/visit/things-to-do>

Yorkshire Lavender: <http://www.yorkshirlavender.com/>

Cotswold Lavender: <http://www.cotswoldlavender.co.uk/>

Wolds Way Lavender: <http://woldswaylavender.co.uk/>

Downderry Nursery: <http://www.downderry-nursery.co.uk/>

3.3.6 Echinacea

Echinacea flowers, also known as coneflowers, are large daisy-like flowers. They can be grown for ornamental purposes (where markets exist for cut coneflowers) as well as cultivated for their root and plant material for medicinal purposes which are sold in a variety of forms including teas, tinctures and powders. In the case of Echinacea supplements (excluding tea and beauty products), it ranks amongst the top 10 herbs in most markets¹⁰.

The commercial Echinacea market is dominated by a handful of firms and large-scale producers. Prices received for Echinacea in the United States dropped in the 2000s from the 1990s, making their cultivation for medicinal applications uncertain at this time.

Growing Echinacea

Echinacea prefers light locations with bright sunlight and grows best in soils with good aeration, drainage and fertility and it commonly requires irrigation to achieve high yields. It can be planted from seed (in glasshouses) or as bare root seedlings or plugs in-field.

Potential for Jersey

As there are at present only a handful of companies producing Echinacea on large scales for mass markets, the opportunity to penetrate larger markets is limited. Small scale production is an option however, if the focus of production was primarily on upmarket, boutique products.

3.3.7 Mint

There are around 19 different types of mint which belong to the plant family Lamiaceae. Each variety of mint varies in its chemical content, aroma and end-use.

Four of the most commonly cultivated and well known types of mint include Japanese Mint (*Mentha arvensis*), Peppermint (*Mentha piperita*), Spearmint (*Mentha spicata*) and Bergamot mint (*Mentha citrata*) from which essential oils can be extracted and used as a flavouring. There are also health benefits attributed to peppermint in particular, including its ability to help reduce the effects of irritable bowel syndrome and other gastric ailments. As well as extraction of essential oils, peppermint leaves can be used, fresh or dried, as a culinary herb and as an ingredient in herbal teas.

The United States and India are two of the largest mint producers in the world, where they produce around 4,000 tonnes/year of *Mentha piperita* and 300,000 tonnes/year of *Mentha arvensis* respectively. In the United States, the oil production from peppermint can vary from

¹⁰ <https://www.uky.edu/Ag/CCD/introsheets/echinacea.pdf>

between 35-80 kg oil/ha. There are very few large-scale mint plantations in the UK; the largest is the 100 acre Summerdown Mint site in Hampshire who grow mainly *Mentha piperita*, peppermint for the production of 1.25 tonnes of peppermint oil per year in an on-farm distiller. The yields on the Summerdown farm are comparatively lower than typical peppermint oil yields; however, the farm owner Sir Michael Colmans attributes the success of his farm and products on the quality of his award winning peppermint and peppermint products he produces. Sir Michael Colmans notes that the peppermint flavours found in more tasteful *Mentha piperita* are losing ground to the harsher tasting and cheaper to produce *Mentha arvensis*. Sir Colmans further states that companies producing confectionary and toothpaste approach mint flavouring with the philosophy of 'do the best you can for this price' which has resulted in lower quality mint flavours in which 'a 'drop' of *Mentha piperita* is used in a larger batch of *Mentha arvensis*. Sir Colmans believes the market desire for higher quality mint products will only increase in response to the poorer quality mint products currently on sale.

Growing Peppermint

Peppermint is a perennial plant which grows well in most soil types (except heavy clays), in an optimum pH range of 6-7.5. Peppermint is also a very thirsty plant that requires moist conditions for growth. Peppermint grows best in cool to temperate regions - requiring long warm days and cooler nights to yield the right balance of oil compounds (less desirable compounds can be produced when conditions are too warm at night). The stems of peppermint grow 30-80cm tall and are quadrangular. Peppermint grows best above the 45th parallel owing to the amount of sunlight.

Peppermint is sown as seed in autumn or spring and is harvested from August to October. Fertiliser is required for good crop development and to maintain oil yield and quality with applications generally in the region of 280kg N/ha, 100kg P/ha and 125kg K/ha. Furthermore, in preparation for growing peppermint, the ground must be completely weed free so a pre-planting herbicide should be applied followed by a post-emergence application where necessary.

Potential for Jersey

Although the scales of production on Jersey are unlikely to fulfil the production capacities required by large companies requiring vast amounts of peppermint oil, there are opportunities for small-scale mint cultivation on Jersey. A small mint farm could operate in a similar manner to Summerdown mint, growing and distilling mint to produce small volumes of very high quality peppermint oil to make high-end peppermint products such as teas, neat oils and chocolates. As these are a rarity in the UK, the potential for a developing a "Product of Jersey" label is significant, to establish Jersey as a peppermint growing island, from which larger scales of production could follow. Furthermore, peppermint as a perennial

plant, offers the opportunity to prevent soil erosion on any areas of land which may susceptible.

3.3.8 Quinoa

Quinoa are tiny bead shaped edible starchy seeds. Although a seed, they are often prepared for consumption like whole grains. The seed is native to South America and is recognised by the United Nations as a 'Supercrop' for its health benefits such as being high in dietary fibre and gluten free.

Potential for Jersey

Quinoa is currently grown on large-scales in the UK by the 'British Quinoa Company'. In contacting the company, they said a lot processing equipment is required for cleaning the quinoa and scales of production would be uneconomic on the island. However, quinoa seeds can be planted on small scales and manually processed for local use. The small production rates on the island however would unlikely result in large revenues. Nevertheless, smaller scales of production could supply businesses and the catering industry on the island of Jersey, especially for those selling premium health products.

3.3.9 Fruit (for Fruit Ciders)

During the 17th-19th centuries, cider making on Jersey was a thriving industry and a key island export with apple orchards dominating Jersey's landscape. However, apple growth and cider production declined in favour of the more profitable Jersey Royals from the mid-19th century until now. Nevertheless, some cider producers do exist on the island (e.g. La Mare Wine Estate, La Robeline Cider Company) which source apples locally.

Expanding apple growth on Jersey for cider production (in addition to standalone fruit production) could be explored. This could be further diversified by growing different fruits to produce a variety of increasingly popular or new and novel fruit ciders. While cider markets forecast that traditional apple cider will continue to dominate over the newer fruit ciders, the fruit cider market is expanding with Smirnoff being the latest large brand to diversify into fruit ciders.

As apple growing and cider production are skills already available on the island, these could be utilised to expand the island's market. As a popular summer drink, producing fruit ciders on Jersey could prove popular with tourists with organised tours as well supply to local businesses and beyond.

Potential for Jersey

The marketing potential of apple and fruit ciders is also significant in terms of “Product of Jersey” credentials. Options for fruit cider flavours could include strawberry (which is already grown on the island) or incorporating the herbs and fruits listed in this report as cider flavours enhancing island circularity of products and developing a niche range unique to the island.

3.4 *Cannabis Sativa* (Hemp and Marijuana)

Cannabis Sativa is an annual herbaceous plant belonging to the genus *Cannabis*. Depending on the purpose of final use, different parts of the plant can be harvested. Currently, *Cannabis Sativa* plants can be cultivated for their fibres (from the stalk), their seeds (which can be consumed) or their leaves (which can be used medicinally or recreationally).

Two well-known varieties of the *Cannabis Sativa* plant are hemp and marijuana. A key difference between these two varieties is their tetrahydrocannabinol¹¹ (THC) content. THC is psychoactive compound, and forms as a resin on the leaves/flower portion of the plant. Marijuana plants typically have a THC content of 10-30% while hemp has a THC content of no greater than 0.3%.

3.4.1 Hemp

Hemp can be used in a number of applications (depending on which part of the plant is cultivated) with estimates that the global hemp market consists of more than 25,000 products¹². Hemp stalks can be utilised for their hurd (also known as the pulp), which is the soft inner core of the plant stem, and their bast fibres, which grow on the outside of the plant. Hemp hurd can be used to make building materials such as fibreboard or ‘hempcrete’ which is a bio-composite mixture of hemp hurd and lime used in construction. Both the hurd and fibres can be used to make paper while the bast fibres can be also be used to make textiles. These include twine, canvas, carpet and even car-parts (brake/clutch linings). The most common application for European hemp fibres in 2010 was for pulp and paper (55%). The next most common application was insulation material (25.9%) followed by press moulding for the automotive industry.

As well as the stalks, hemp can be cultivated for its seeds which can be consumed or used to produce hemp seed oil – this requires a slightly different variety, known as dual-hemp. According to a recent report from Technavio, the global hemp-based foods market is expected to post a compound annual growth rate (CAGR) of more than 20% during the

¹¹ THC elongs to a larger group of compounds called cannabinoids.

¹² <https://www.fas.org/sgp/crs/misc/RL32725.pdf>

period 2016-2020 indicating reasonable market expansion. The relative price index of hemp fibres has on average increased since 2012.

Hemp cultivation in the EU has increased rapidly in the past few years, from around 14,000 ha in 2012 to just over 25,000 ha in 2015¹³. In 2013, 15,700 ha were grown generating 85,000 tonnes of straw which were processed to 43,000 tonnes of shiv, 25,000 tonnes of fibre and 13,000 tonnes of dust used to make pellets (60%) and compost (40%). The main market for hemp shivs in 2013 was for horse animal bedding (45%). From 2010-2013, the production of fibre and shivs did not show any significant difference.

In 2013, 11,500 tonnes of hemp seed and 240 tonnes of flowers and leaves were processed for medical applications (THC/CBD), food supplements (CBD) and production of essential oils. Previously, seeds were seen as a by-product of hemp fibre production in the EU however in the past few years, production of hemp for seed exclusively has increased. The production of seeds from 2010-2013 increased by 92% (from 6,000 tonnes) driven by demand from the food market, with large supermarkets even now exploring the hemp market. The main market for hemp seeds are animal feed and food with comparatively smaller oil markets. Regarding seed for food, the tonnage increased from 1,000 tonnes in 2010 to 5,000 tonnes in 2013.

3.4.2 Hemp with High Cannabidiol (CBD) content

Although hemp has low concentrations of THC, certain cultivars have high amounts of a different type of cannabinoid called cannabidiol (CBD). CBD research has exploded in the past few years and the compound has been dubbed 'the poster child of medicinal cannabis in 2016'. Unlike THC, CBD is non-psychoactive and therefore 'feeling high' is not one of CBD's effects. CBD concentrations vary from cultivar to cultivar but in general it is found in the upper part of the plant in the flowers. Very recently it has gained prominence in the pharmaceutical and food supplement industries¹⁴. In the EU, the production of flowers and leaves from cannabis increased 3000% from 7.5 tonnes in 2010 to 240 tonnes in 2013.

CBD has only been legal in the UK since July 2015 and since its legalisation, a variety of CBD products are now being sold. The demand for these products derives from the reported medicinal properties of CBD which include antibiotic, analgesic, anti-depressant and anxiolytic as well as being researched for its neuroprotective properties. One UK based company selling CBD products from a variety of different brands¹⁵ is UKCBD (<https://ukcbd.com/>) with items including gels, transdermal patches, capsules, vaping liquids and crystals. Regarding CBD and clinical medical application, GW pharmaceuticals, a biopharmaceutical company who develop and commercialise novel therapeutics from its

¹³ <http://eiha.org/media/2016/05/16-05-17-European-Hemp-Industry-2013.pdf>

¹⁴ <http://eiha.org/media/2016/05/16-05-17-European-Hemp-Industry-2013.pdf>

¹⁵ ADD BRANDS

proprietary cannabinoid product platform recently announced second positive phase-3 pivotal trials for their CBD 'Epidiolex' product in the treatment of Lennox-Gastaut Syndrome which is a form of epilepsy.

According to a recent market study¹⁶ on cannabidiol, the CBD market is currently dominated by SMEs. The report also states that as a relatively new product, it has one of the greatest potential growths of the hemp products. Unlike marijuana, there are no specific security requirements for growing low THC (<0.3%) hemp in the UK however the Home Office does request that any plantations are sited sensitively and they are notified of its production¹⁷.

Growing Hemp

Hemp will grow on most soils suitable for conventional arable crops however acidic soils will reduce yields (if the soil is lower than pH6, lime must be applied before initial cultivation). Poorly drained and sandy soils should be avoided. Hemp seeds are drilled in late April to early May when the risk of frost has passed and the soil temperature is consistently above 10°C. Rows should be planted 12.5-25cm apart and seeds placed at a depth of 4cm. The final application of the hemp will dictate the seed rate. If cultivated for fibres, research¹⁸ has shown that no more than 80kg seed/ha is required. If non-textile fibre is the final application, 30kg/ha may be adequate.

Recommended N levels for growing hemp are around 80kg/ha prior to sowing or applied with the seed, plus an additional 80kg/ha should be applied as a top dressing when the crop has five pairs of new leaves. Phosphorus and potassium recommended levels are 160kg/ha and 80kg/ha respectively. The levels of fertiliser should be reduced if organic manure is applied.

Fibre and seed yields vary depending on variety. Fibre yields can range from 12 tonnes/hectare (low productivity) to 20 tonnes/hectare (high productivity). If cultivated for seed, an average seed yield is around 550-690 kg/hectare while a good yield is 890-1000 kg/hectare (high productivity). Around 20kg of seed is required to make 1 gallon of oil.

Details of hemp seed providers can be found in the Appendix.

¹⁶ <http://eiha.org/document/growing-markets-for-hemp-food-and-pharmaceuticals-potential-billion-e-markets-in-europe/>

¹⁷ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/480810/Hemp-_FAQs-Grower_notes-2014.pdf

¹⁸ Little difference in final yield observed between 60-100 kg/ha
<http://www.hoajonline.com/journals/pdf/2052-6237-2-1.pdf>

Potential for Jersey

As the hemp market has undergone growth in the past few years, it represents a market Jersey could penetrate. As a number of products can derive from hemp however, it is important farmers on the island select the right product to cultivate which will complement the facilities and infrastructure on the island as well as provide acceptable rates of return. Regarding cultivation for fibres, this presents an option however in order to produce the final product on-island it would require the correct machinery and facilities which can firstly harvest the shiv and then convert to usable products such as hempcrete. While the raw fibre material could be exported off island, the fibres are bulky relative to other hemp products and so other products may be better explored. These include hemp seeds, which are less bulky and fall under the health foods category which is currently on trend. The seeds can also be utilised for their hemp seed oil which, providing oil extraction facilities were available on the island as recommended in part one of this research, diversifies the seed-based product which could be produced.

The cultivation of hemp with high-CBD content could also be explored following recent legalisation in the UK. A number of products high in CBD can be sold at very high retail prices relative to the same product without CBD e.g. lip balms, creams, vaping liquids. Furthermore, as interest in CBD by pharmaceutical companies has emerged which have led to clinical trialling of CBD drugs, the demand for CBD-rich hemp may correspondingly increase.

Useful contacts

<https://ukcbd.com/>

<http://medicalmarijuana.co.uk/first-cbd-oil-in-the-uk-goes-on-sale/>

All of the hemp providers listed below are members of the European Industrial Hemp Association (EIHA):

<http://www.npkssl.com/>

<http://northeastheritage.com/tag/hemp-seed/>

<http://www.hempoland.eu/>

<http://hempflax.com/en>

<http://www.agropro.it/en/>

<http://www.ihempfarms.com/>

www.PlanetHemp.ca

3.4.3 High-THC Cannabis (Marijuana)

The global market for high-THC (0.3%) cannabis (commonly known as marijuana) is estimated at \$10-120 billion. While its market value makes high-THC cannabis very lucrative, it is illegal in almost all countries in the world in terms of its recreational use. However, high THC cannabis can be prescribed legally in several countries for medical purposes.

In the UK, high-THC cannabis is a Class B (intermediate category) controlled drug where producing, supplying, possessing, importing or exporting it requires a Home Office License¹⁹. On obtaining a license to grow high-THC cannabis in the UK, there are general requirements in place for growing controlled drug licensees. These include ensuring external doors and windows are fitted with secure locks, that stock is (where permitted) stored above ground level and the site has an alarm system with certain degree of police response to name a few²⁰.

The only licensed high-THC cannabis medical product available in the UK is Sativex, (produced by GW Pharmaceuticals) which is mouth spray used for treatment of spasticity due to multiple sclerosis.

Potential for Jersey

Despite its value, the legal status and strict medical application of high-THC cannabis in the UK limits the opportunities for Jersey currently. In contacting GW Pharmaceuticals they informed NNFCC that they currently grow or tightly control their entire high-THC cannabis supply to ensure strict quality control; although they now contract with one external party they are not currently looking for additional suppliers. If there is any change in the legal status or sourcing strategy for marijuana however, the glasshouse network on Jersey could be used to grown high THC cannabis.

3.5 Energy Crops

Energy crops are crops which are harvested exclusively for energy purposes. This requires the crop feedstock to undergo 'conversion' to release the chemical energy stored within. Conversion can be thermochemical (e.g. combustion) or biological (e.g. anaerobic digestion). In part one of this research, some energy crops were presented as opportunities (Short

¹⁹ <https://www.gov.uk/guidance/controlled-drugs-licences-fees-and-returns>

²⁰ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/526557/Security_Guidance_for_all_Businesses_and_Other_Organisations-_Final-_May_2016.pdf

Rotation Coppice and Miscanthus). Two additional options are presented below which could be explored for use on the island as part of a larger sustainability strategy.

While energy crops are not necessarily considered a 'cash crop' per se, they could potentially offer indirect financial benefits by replacing other forms of energy on the island and improving self-sufficiency. This may become significant if additional energy costs are the result of energy intensive processes attributed to some of the products listed in this report.

3.5.1 Switchgrass

Switchgrass (*Panicum virgatum*) is a warm season perennial grass native to North America. Historically, switchgrass has been used in North America as a cover crop and for forage. However, its application as an energy crop is very versatile as it can be used in direct thermochemical conversion (e.g. combustion), in cellulosic ethanol production as well as in anaerobic digestion systems (biological conversion). One of the key benefits of growing switchgrass for energy is that the grasses can be grown on marginal land and is adaptable to many soil types.

Growing Switchgrass

Switchgrass is established from seed using conventional drilling machinery and grows up to 1-3m tall depending on crop maturity. Establishment is slow however, taking up to 2-3 years, yet once established, Switchgrass will continue to yield for 10 or more years. Once mature, harvesting takes place annually from October to December and yields a maximum 14 tonnes of dry matter per hectare. Harvesting is undertaken with conventional grass mowing and baling equipment which is available on Jersey. It has low input costs (around £357/ha) and the gross margin should increase as the crop becomes more established.

Potential for Jersey

Without advanced ethanol production facilities on the island, direct combustion of the grass (in small-scale boilers) would be a better application for this grass. If AD facilities were developed on the island, switchgrass could be a potential feedstock. In conjunction with the tourism industry on Jersey, switchgrass could be co-digested with food waste from these hotels and restaurants to produce biogas via AD. This biogas could then be burned to produce electricity (reducing the reliance on interconnectors) and heat for local use, or upgraded to biomethane to be burned in heating systems (reducing reliance on imported fossil fuels for heat applications). These options would not only provide energy security but also contribute towards Jersey decarbonisation targets.

Growing energy crops on marginal land would ensure there are no land competition issues (with food production) as well as enabling land that would otherwise lay dormant to be

utilised, potentially maximising land-use on the island. Nevertheless, Switchgrass grows best on well drained soils of medium fertility. Switchgrass has a further added benefit of requiring low or no nutrient input and little or no irrigation once established.

3.5.2 Reed Canary Grass

Reed Canary Grass is also a perennial grass, naturally distributed throughout Europe and temperate regions of North American and Asia. Similar to switchgrass, reed canary grass can be used as energy crop and attains high yields on poor soils making it a good crop for marginal land. Also similar to switchgrass, establishment can take 2 years following which the grasses can be harvested using specialised equipment. Yields range from 3-7 tonnes/hectare.

As well as energy crop applications, the extensive rhizomatous root system of reed canary grass provides excellent erosion control, in particular along stream banks, shorelines and waterways. This grass therefore could be explored as an alternative on the former potato growing soils along the coast, if soil erosion is particularly problematic.

Potential for Jersey

Opportunities for reed canary grass are identical to switchgrass, as described above. However, reed canary grass requires a lot of nitrogen for reasonable yields to be achieved which may exacerbate the water nitrate problems and makes this a less attractive option for Jersey than Switchgrass.

4 Conclusions

As a result of this research it is clearly evident there are a vast range of opportunities for Jersey to diversify its agricultural activities and combine existing skills, knowledge and resources with new market opportunities to improve returns. The strongest opportunity, or combination of opportunities, lies within the super-food and health-food industries, linking production of berries or fruits with tea or cider production for example to develop opportunities which are unique to Jersey. Such opportunities are likely to attract a premium over conventional food ingredients as novel foods are currently on trend, with interest from leading brand owners increasing.

Due to the specialist nature of the planting and harvesting equipment for many of these alternative crops, the initial focus should be on small-scale where harvesting can be done manually, eliminating the need for investing in and importing specialist, typically larger scale, harvesting equipment until production, processing and the market starts to become established. This will also utilise available skills and labour resources on the island. Furthermore, some relatively low investment in new or upgraded on-island drying facilities would allow drying of a multitude of products, such as teas, herbs and berries to extend shelf lives and broaden the market and product potential.

5 Appendix

5.1 Vegetables grown outdoors

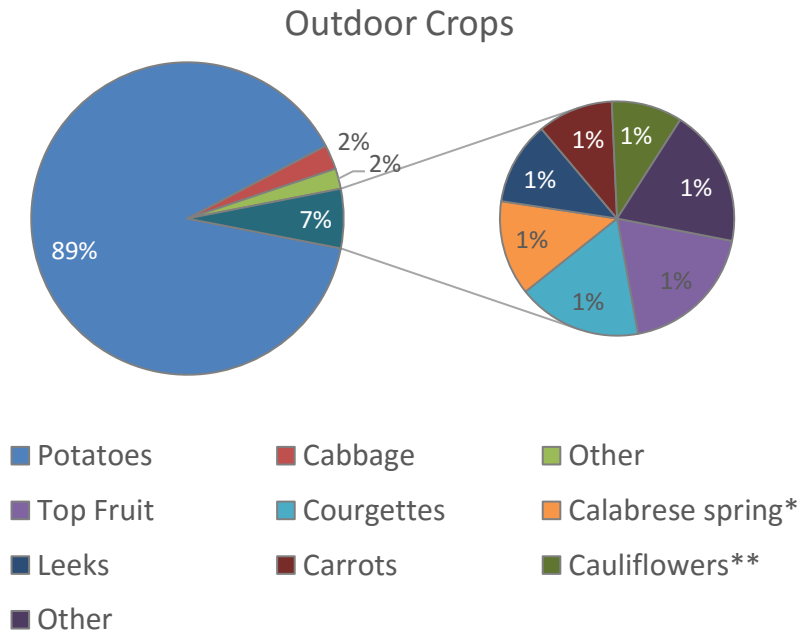


Figure 1 – % of Vegetables grown outdoors on Jersey in 2014

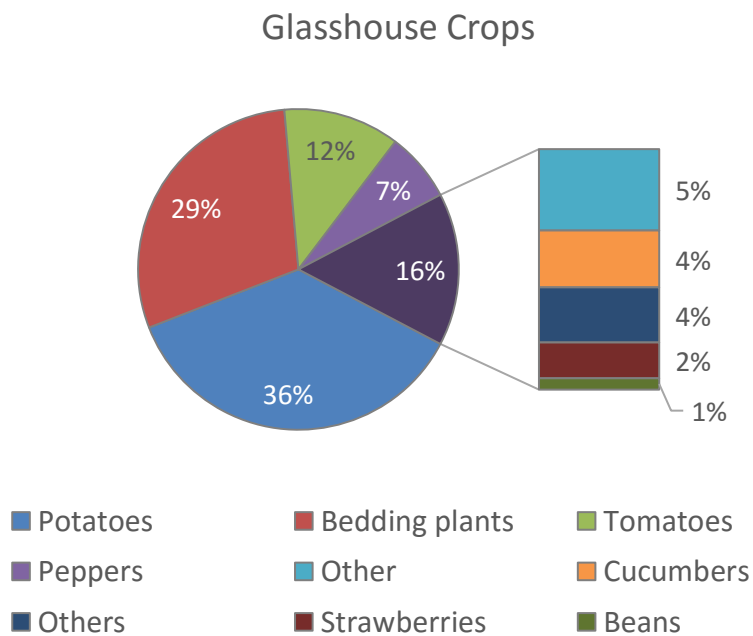


Figure 2 - % of crops grown in glasshouse on Jersey in 2014

5.2 Industrial Hemp Industry

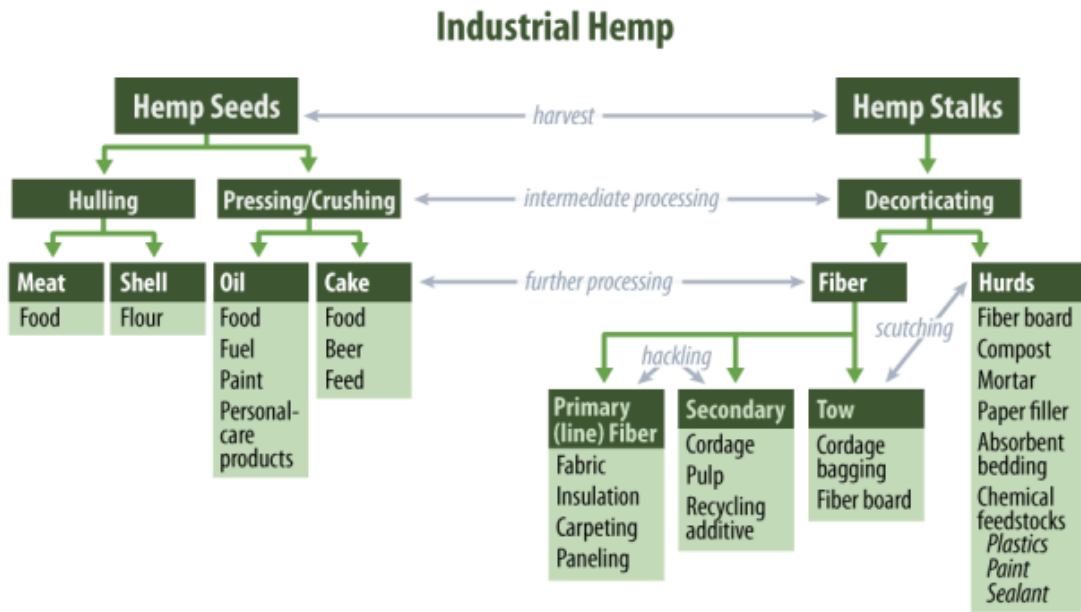


Figure 3 – Uses for Industrial Hemp²¹

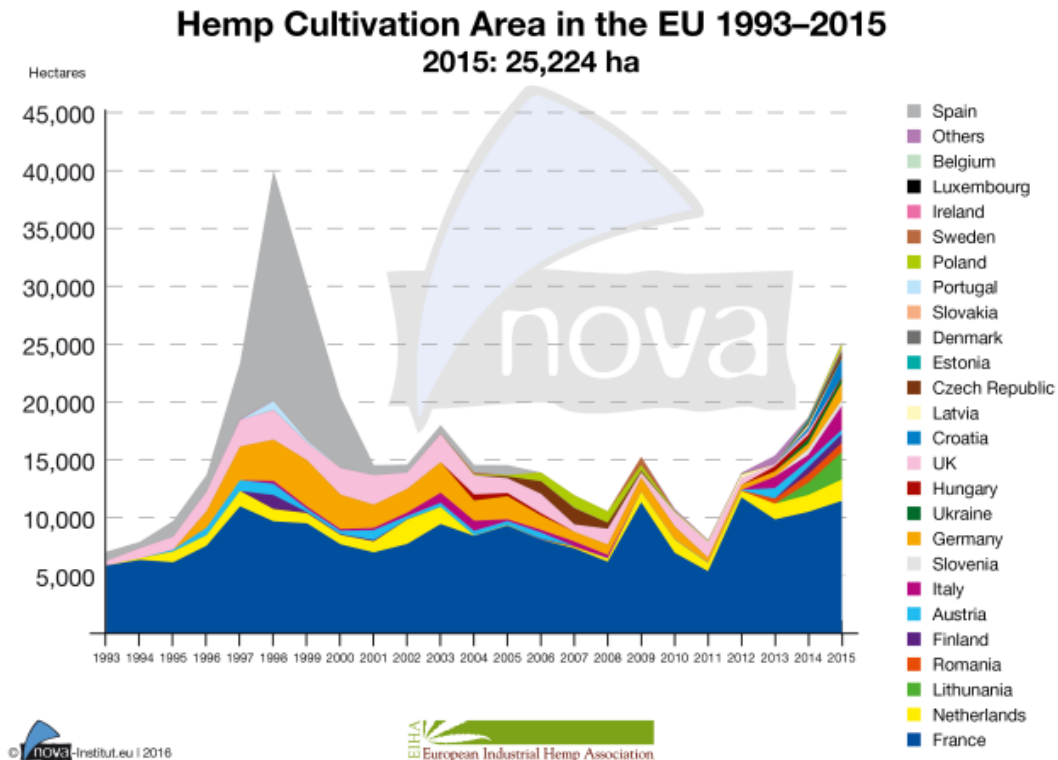


Figure 4 – Hemp Cultivation Area in the EU 1993-2015²²

²¹ <https://www.fas.org/sgp/crs/misc/RL32725.pdf>

²² <http://eiha.org/media/2016/05/16-05-17-European-Hemp-Industry-2013.pdf>

NNFCC

NNFCC is a leading international consultancy with expertise on the conversion of biomass to bioenergy, biofuels and bio-based products.



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