



**A Nuffield Farming Scholarships Trust
Report**

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**Advancing British
sea buckthorn**

Seth Pascoe

July 2016

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A Nuffield (UK) Farming Scholarships Trust Report



Date of report: July 2016

*"Leading positive change in agriculture.
Inspiring passion and potential in people."*

Title	Advancing British sea buckthorn
Scholar	Seth Pascoe
Sponsor	National Farmers Union Mutual Charitable Trust
Objectives of Study Tour	<ul style="list-style-type: none">• To learn more about the production, processing and marketing of sea buckthorn• To raise general awareness of sea buckthorn in the U.K.• To visit new and established fruit, niche, and other challenger businesses to study their business model and to learn about the challenges and opportunities they have encountered
Countries Visited	Belgium, France, China, Hungary, Romania, Latvia, Sweden, Denmark, Germany, India, U.K., U.S.A
Messages	<ul style="list-style-type: none">• Sea buckthorn can satisfy the demands of a consumer demographic that is increasingly health conscious• Sea buckthorn is a bona fide functional food• Inefficient harvesting restricts the crop's potential• Developing the market is a sizeable challenge, but also a big opportunity too• A strong brand with excellent communication will be necessary in order to educate the consumer about the benefits of sea buckthorn

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Chapter 1: Introduction

I live with my girlfriend Laura and my dog Dyson in beautiful Cornwall. We are both self-confessed ‘foodies’. We enjoy entertaining at home and tasting the culinary treats that our county has to offer.

I have been passionate about agriculture since an early age. I spent quite a bit of my childhood busily carpet- and sandpit-farming with my collection of Britain’s model tractors. I then progressed to stacking conventional “idiot cube” hay and straw bales for a neighbouring farmer during the harvest.

In 2008 I graduated with a BSc Honours degree in crop production from the Royal Agricultural College, Cirencester. I spent a few years involved within the dynamic fresh produce industry in West Sussex, where I also successfully achieved my professional BASIS & FACTS agronomy qualifications.

I decided to broaden my horizons and spent four years running a potato and arable farm in Alberta, Canada. Avid Farmers Weekly readers may recollect my monthly ‘Arable Farmer Focus’ column. I returned to Cornwall in 2013 shortly after my 30th birthday. I now work as an agronomist, assisting farmers across the county with maximising their crop production.

I consider learning through travelling to be one of the most informative, exciting, interesting and humbling experiences in which a person can participate. It’s quite possible that I wouldn’t have discovered sea buckthorn if it wasn’t for travelling.

I enjoy a fairly active lifestyle. I am a member of Charlestown Rowing Club. We row in Cornish Pilot Gigs, old-fashioned wooden boats with six rowers and a coxswain. Weekends are spent competing in regattas at various venues around the Cornish coastline. I also really enjoy hiking; both locally with the dog on the scenic southwest coast path and further afield, conquering summits and trekking in various mountain ranges across the planet.



Figure 1: the author, Seth Pascoe, pictured beside sea buckthorn



Chapter 2: Background to my Nuffield Farming Scholarship study

They say that agronomists are just frustrated farmers. By and large I think that sweeping statement sums me up nicely. Growing up on a horticultural smallholding in Cornwall, I was always on the lookout for a novel crop to grow - something different. A crop that didn't require vast tracts of land to provide sensible returns, yet something that was also unique and exciting to grow.

My first encounter with sea buckthorn came in 2012 when I was trekking to Mount Everest base camp in the Himalayas. We had climbed up to an altitude of 4000m and the lack of oxygen in the thin mountain air had started to give me altitude sickness. I suffered with nosebleeds, dizziness and grinding headaches.

One evening we were all huddled around the 'log' burner playing cards. The pungent aroma of burnt yak dung lingered heavily in the cold mountain air. The Sherpas brought each of us a glass of bright orange coloured juice, telling us it would help to alleviate our various altitude-induced ailments.

The juice had a unique, tangy, refreshing and delicious citrus-like taste, unlike anything I had previously experienced. The following day I felt fully rejuvenated. I asked the Sherpa what the magical juice was and of course it was sea buckthorn. I enthusiastically learnt all I could about sea buckthorn from the Sherpas for the remainder of my time in Nepal. I could tell they thought it was rather peculiar for an Englishman to develop such a sudden interest. Nevertheless they were more than happy to help and told me with great pride all that they knew about their Nepalese super-fruit.

Upon my return from Nepal, sea buckthorn was never far from my mind. I spent considerable time researching the crop, keen to further my knowledge. I was walking my dog on the glorious South West Coast Path when I made an unexpected discovery. I happened upon an area of rather familiar looking foliage. There it was, in all its glory, growing wild in Cornwall.

The media nowadays are awash with stories about health scares and worldwide epidemics. Sadly, as we are all too aware, bad news makes good news. There is a media-feeding frenzy and furore each time a new story emerges.

Our National Health Service (NHS) is buckling under the pressure from insurmountable patient numbers and a diminishing budget. Many of the public health problems and the consequential burden on the NHS are related to poor lifestyle and diet choices. Obesity is regarded as an epidemic problem in the UK, with one in four adults and one in three children affected. Obesity increases the risk of other serious and potentially life-threatening illnesses such as type 2 diabetes, heart diseases, high blood pressure, strokes and some forms of cancer (*NHS:2016*).

With an ever increasingly health conscious public and the on-going shift in consumer trends towards healthier lifestyles and diets, it seemed like sea buckthorn and its health-beneficial attributes represented a great opportunity. I decided that I would establish a commercial orchard in Cornwall.

I encountered two obstacles almost immediately. Firstly, the UK knowledge pool on sea buckthorn is very small and secondly very few people know about the fruit. I decided to apply for a Nuffield Farming Scholarship to try and resolve these issues. Fortunately, the selection panel accepted me.



Chapter 3: The where, when and why for my study tour

	<p>Brussels, Belgium: February 2015</p> <p>All the new 2015 Nuffield Farming Scholars took a Eurostar to Brussels. We visited the European Parliament, British Agricultural Bureau and had a chilly tour of the Battle of Waterloo battlefield. At this stage the UK referendum was only mentioned in passing.</p>
	<p>Reims, France: February 2015</p> <p>The location of our Contemporary Scholars Conference¹, held in the heart of the Champagne region. An interesting week of talks, visits and discussions on French and world agriculture amongst other topics. My perspective and views were challenged. I was forced to re-evaluate my preconceived ideas and I came away a better person. A modest quantity of the finest champagne was consumed along the way too.</p>
	<p>Ordos/Beijing, China: August 2015</p> <p>China has the largest area of sea buckthorn in the world. Also, one of the oldest known references to the fruit is in ancient Chinese medicinal texts. My fantastic hosts were very hospitable. I persevered and just about mastered the use of chopsticks for almost the entire duration of my visit. It was fascinating to visit this country, both from a sea buckthorn perspective and in the broader sense.</p>
	<p>Budapest, Hungary: August 2015</p> <p>Used this lovely city as a base for a couple of days. Travelled onwards into Romania (twice). Of note was a flood height marker on the banks of the Danube: many of the largest floods had occurred in the past 10-15 years, a telling sign of climate volatility?</p>
	<p>Arad, Romania: August 2015</p> <p>I visited a jovial grower/breeder with possibly the largest sea buckthorn plant-raising nursery in Europe. We shared an appreciation for John Deere equipment.</p>
	<p>Riga, Latvia: August 2015</p> <p>Here I visited sea buckthorn growers, breeders, researchers and scientists across the north of the country. My first real insight into sea buckthorn fly. I was taken aback with how beautifully wooded the countryside was, making England look like a barren prairie in comparison.</p>
	<p>Kristianstad, Sweden: August 2015</p> <p>Visited a government research scientist/breeder with a small processing facility. Breeding efforts were concentrated on producing a sweeter tasting fruit. I saw sea</p>

¹ 2-week leadership training Conference organised by the Nuffield International Farming Scholarships organisation, which all new Nuffield Farming Scholars, internationally, in a given year attend.



	buckthorn products widely available on supermarket shelves. Very efficient and timely public transport.
	Copenhagen, Denmark: August 2015 I hadn't planned on visiting Denmark other than disembarking to change trains somewhere. However the power of a simple Twitter conversation lured me into Copenhagen. I was on the search for a highly recommended restaurant that featured sea buckthorn on the menu. I deemed it an essential piece of research and ensured that I set off with an empty stomach.
	Hamburg, Gülzow, Potsdam, Quellendorf, Germany: September 2015 In Germany I went to visit a plant raiser from whom I source young sea buckthorn trees. I met with a research scientist, a fruit juice manufacturer and several growers. One large grower has one of the very few self-propelled mechanical sea buckthorn harvesters. I also met a grower who has successfully diversified her business into an agri-tourism destination 'sea buckthorn world'.
	New Delhi, Leh, India: November 2015 I was the sole British delegate at the 2015 International Sea Buckthorn Association conference. After the hectic hustle and bustle in one of the world's largest cities, I flew up into the beautiful Himalayas to see one of the sea buckthorn growing regions and a handful of ancient Buddhist monasteries.
	New Jersey, New York, Connecticut and Massachusetts, USA: January 2016 My trip to America was to make observations and comparisons on other healthy fruit crop enterprises. These were aronia, blueberry, cranberry and blackcurrants. More specifically I wanted to examine how growers and/or industry organisations came together to promote and market the produce. My top tip is not to ignore the advice of the friendly car hire company staff and ensure you DO get an auto-toll tag for your hire car. Not having one makes life on a road trip rather complicated.
	Various Counties, UK: 2015-16 I visited various businesses, attended various conferences, seminars and visited people who I thought would offer valuable contributions towards my study objectives.

I intend to write this report in an informative and straightforward manner. I hope to give you – the curious reader - an insight into a fruit that you have probably heard very little about.

I shall start by **introducing** sea buckthorn. I will try to furnish you with some **information**, in order that you may gain an understanding about the fruit. Then, I will go on to discuss what I consider to be **important agronomic topics**, both challenges and opportunities. **Marketing** will be the final and possibly most intrinsic consideration.



Chapter 4.0: What is sea buckthorn?

(*Hippophae rhamnoides*) is a member of the elaeagnaceae family; which comprises small trees and shrubs, native to temperate regions and generally found in the northern hemisphere.

It's a perennial, woody, deciduous plant with silvery-green narrow leaves and intermittent thorns. It can grow as large as 8-10m in height, although 1-4m is more common. Wild plants will commonly live for between 30-60 years, whilst commercial orchards usually sustain production for 10-15 years on average (Singh:2011).

Sea buckthorn is dioecious; having separate male and female plants. Female trees are fertilised by male trees via wind pollination. As insects are not required for pollination, the flowers are quite discrete and not resplendent.

The plant has a relatively shallow rooting habit. The main root mass extends horizontally from trees at a depth of 10-40cm. The plant also has vertical roots that can grow down to a depth of 3m. These anchor the tree and seek out soil moisture and nutrients from depth.

An actinomycetes soil bacterium called *frankia* has a symbiotic relationship with, and fixes, atmospheric nitrogen on root nodules. The quantity of nitrogen fixed is thought to be similar to that of leguminous rhizobia, adding around 180Kg/Ha of nitrogen annually (Jike, Xiaoming: 1992).

The fruit grows in tight clusters on female plants, typically on two-year-old branches. Seaberries are commonly spherical, cylindrical or elliptical in shape and are attractively coloured in red, red-orange, bright orange or yellow. The berry size varies according to cultivar and the season, but usually ranges between 6-12mm.

Sea buckthorn prefers sandy, free draining soils. However as a pioneering plant, it is highly adaptable to a wide range of soil and climatic conditions. I have seen it thriving in deserts in China, on high altitude weathered bedrock in the Indian Himalayas and in drained marshland in Latvia. In the UK wild sea buckthorn is usually found growing in sand dune locations.

A soil pH at or close to neutral is optimal for sea buckthorn production, although it doesn't seem to be a limiting factor and can still grow in soils with pH ranging from 5.5 to 7.5. It can also tolerate or adapt to soils with high salinity too.

Another remarkable attribute is sea buckthorn's ability to sustain extremes of temperature. Plants have endured temperatures ranging from +40°C to -40°C, although that is variety dependent.

Whilst it is considered that sea buckthorn is drought tolerant, it is actually a moisture sensitive plant. Inadequate soil moisture, particularly during early spring, can negatively impact flowering and fruit set. Sea buckthorn can endure lengthy periods of drought better than other woody shrubs, but under such conditions high fruit yields would not be expected. Production areas receiving less than 400mm of annual rainfall should provide supplemental irrigation. Under dry conditions irrigated fruit yields were 100% higher than those of trees not receiving irrigation (Höhne: 2015).



Sea buckthorn is strongly phototropic and prefers to grow in full sunlight. Under shaded conditions the plants tends to grow in a distorted manner and often will not bear fruit.

4.1: The history of sea buckthorn

The Latin name for sea buckthorn – *hippophae rhamnoides* - translates from the Greek word *hippo*, meaning horse, and *phaos*, which means to shine. Therefore the literal translation is shining horse. In ancient times sea buckthorn leaves were fed to horses which then noticeably improved in condition, gaining weight and having shiny coats (*Rongsen:1992*).

There is some mythology surrounding sea buckthorn and the mythical winged horse Pegasus. Legend has it that Pegasus’s favourite snack was a berry that grew at high altitudes – sea buckthorn.

It is rumoured that the medicinal properties of sea buckthorn did not escape the attention of a certain Mr Genghis Khan. Good horses were key to victorious battles and to communication across vast empires. Legend has it that after one battle, injured, old and weak horses were left to die next to some sea buckthorn shrubs. When Genghis Khan next passed through the area (returning from another victorious campaign no doubt), they came across these horses: strong and fully reinvigorated, the horses whinnied when they saw their former soldier masters. Khan commanded his soldiers to pick the berries and to take them daily. Feeding his horses and his soldiers sea buckthorn replenished them and gave them the energy, strength and endurance to win many more battles.

Pliny The Elder made one of the oldest known factual references to sea buckthorn in his books on natural history, written in 77-79AD. One chapter is titled “Two varieties of the hippophaes: two remedies”. He refers to the fact that the name is derived from its suitability to treat horse ailments. This also indicates that botanists had already named and identified its usefulness at a prior date.

The medicinal properties of sea buckthorn were first mentioned in the ancient Tibetan Buddhist medical texts ‘rGyud Bzi’, written in the 8th century. There are many prescriptions in which the use of sea buckthorn is described in detail.



Figure 2: Schenkenberg, Germany 2015: a commercial sea buckthorn orchard



4.2: Sea buckthorn today

In more modern times the Chinese supplied sea buckthorn as the official drink to their athletes, giving them strength and energy to perform at the 2008 Beijing Olympics. Coincidentally China went on to win the most gold medals and came first overall.

The Indian Army provides sea buckthorn juice to soldiers to help alleviate altitude sickness at high altitude border patrol bases in the Himalayas. The main military base is Leh, at an altitude of 3500m. Due to border discrepancies over the years with neighbouring Pakistan and China, India have some 80,000 soldiers based there. Soldiers are flown in from New Delhi (216m) before going on to perform duties at even higher altitudes. Inevitably, altitude sickness has caused many casualties in the past and the army is now using sea buckthorn to try and prevent this. The Defence Research and Development Organisation (DRDO) has also developed a sea buckthorn-based skincare product to combat the higher levels of ultra violet radiation experienced at altitude.



Figure 3: Sea buckthorn in the Leh, Ladakh region, Indian Himalayas 2015

Russian cosmonauts use sea buckthorn juice and oil as part of a nutritional plan to counter the intense cosmic radiation found in space. Yuri Gagarin took sea buckthorn before becoming the first human to travel into space in 1961.

Yurijs Ovsjannikovs was one of the first people to establish a commercial orchard in Latvia in the 1990s. When I asked why he chose sea buckthorn he simply said:



“For the Russians to put anything into space it costs them weight for weight the same value as gold. Every time they go to space they take sea buckthorn with them, so to me that makes it a crop that’s as valuable as gold”

He also added that a crop that can grow itself without using vast quantities of artificial pesticides or fertilisers and yet produces a fruit that is beneficial to health was a big attraction and seemed logical.

In the UK, sea buckthorn is beginning to catch the eye of celebrity chefs, with both Hugh Fearnley-Whittingsall and Nathan Outlaw featuring the berries as unique ingredients in their recipes.

4.3: Distribution

The orange area in the map below shows where sea buckthorn grows worldwide. Please refer to the Appendix at end of this report for the fully itemised list of countries.



Figure 4: map showing where sea buckthorn grows worldwide

Commercial cultivation of sea buckthorn reportedly started in China and Russia in the 1930s.

Reputedly, 95% of the global sea buckthorn population can be found in China, where the total area is thought to be well in excess of two million hectares. However, this is not all in commercial fruit production. The plant is also used extensively to prevent soil erosion. Please see case study one on next page.

In North America, sea buckthorn is not a native species. It was purposely introduced as a shelterbelt plant for use on the prairies. At some point in time, people began harvesting the fruit from the trees. Subsequently some commercial orchards were established, predominantly in Canada where the national commercial crop area is thought to be around 400Ha.

The 1992 sand dune survey of Great Britain recorded an area of approximately 650Ha of sea buckthorn (*Houston and Weaver: 2009*). Approximately 250Ha of that was native sea buckthorn, with the remainder being planted for conservation purposes. Presently, the national commercial sea buckthorn crop is in the region of a mere 10-15Ha.

In India, vast wild sea buckthorn forests exist in the Himalayas. In the principal production region of Ladakh, some 15,000Ha of sea buckthorn prevail. However, some areas of the forest are so thick they



are impenetrable and other areas inaccessible due to terrain. This causes obvious constraints to the harvesting of fruit. The Indian Ministry of Environment & Forests (MoEF) has recently granted permission for some commercial orchards to be established, in order to improve the productivity of the industry.

Similarly in Nepal, wild sea buckthorn is found at altitude growing on Himalayan mountainsides, river valleys and glacial moraine. Strong local industries exist, where the sea buckthorn juice is sold to trekking tourists, the pulp is fed to yaks/donkeys/chickens, and the wood is used as a heating fuel. Access to the more populated lowlands is logistically challenging, preventing further expansion of the industry. The devastating 2015 earthquake has added further setbacks to the industry.

In Europe: Germany, Finland and the Baltic States lead in terms of commercial production areas. The industry has been around since the 1970s and modest expansion continues each year. Some planting was opportunistic, specifically taking advantage of an available EU subsidy. It is thought that these areas are now abandoned and not actively managed or in production.

Case Study One: Sea buckthorn – a conservation hero

As well as the commercial fruit production aspect, one must not discount the merit sea buckthorn offers in terms of a conservation species. This represents a significant area globally, much more so than the commercial fruit-producing area.

The Conseco Company raises some 6 million sea buckthorn plants each year at their nursery. Of that total figure only 1 million are destined for commercial orchards. The Chinese Government uses the lion's share on conservation projects. Here are three examples where sea buckthorn is being utilised.

1. The Yellow River is known as the 'mother river' of China and is held in high regard: "*the health of the river is the health of the nation*". Depending on the source, soil erosion results in as much as 400 billion tons of soil entering the river each year. The sedimentation causes the river levels to rise and consequently frequent flooding occurs. Chinese experts deem the sandstone erosion a 'cancer of the planet'.

The catchment area for the Yellow River is largely dominated by sandstone desert, where there is very little vegetation. Dry valleys and gullies dominate the topography of the area. The sandstone is victim to freeze-thaw and wind erosion. It's very hard when dry, but becomes very frail when wet. When rain events occur, unobstructed rainwater pours off the landscape, causing severe soil erosion as it goes.

Sea buckthorn (*spp. Sinensis*) is one of the few species that can sustain growth in the harsh sandstone desert environment. Planting on slopes and valley bottoms started in 1999 and now covers an area of 4500Km². This has stabilised the soil and successfully impeded the flow of rainwater. The water level of the Yellow River has dropped, biodiversity has increased (in both the



river and the sandstone regions) and soil erosion has reportedly dropped to 160 billion tons/year.



Figure 5: A typical sandstone landscape in China. Note sea buckthorn scrub on hillsides

2. The Kubuqi desert, Inner Mongolia, is the 7th largest desert in China and, at 35,000 square miles, covers an area four times the size of Wales. The majority of Beijing's infamous sandstorms originate from this desert. The Chinese government implemented a number of ecological initiatives to reduce the sandstorms. One such project was planting sea buckthorn to stabilise the sand dunes. It was a success: the frequency and severity of subsequent sandstorms were greatly diminished.



Figure 6: Sea buckthorn scrub in the Kubuqi desert

3. Ordos, Inner Mongolia, is an open cast coal mining area. The coal seams are at a depth of 30-50m below the surface. To access the coal, the mining companies bulldoze off the surface layers and create spoil tips adjacent to the



mines. Once they finish extracting coal from a site they backfill it with the soil, rock and rubble from the tips, and then move on to the next site. The land is then provided rent free for reclamation into sea buckthorn production. Its pioneering growth habit makes it one of the few plants able to grow in such situations.



Figure 7: Sea buckthorn plantation in the foreground, opencast mining in the background

4.4: Products

In common with most other fruits, there are a wide range of products in which sea buckthorn can be used. One advantage sea buckthorn offers is that, on the whole, market value is generated through value-added processing. Products will tend to have a longer shelf life and an extended year-round sales period. It also negates the seasonality of production and can help to stabilise cash flows. This property is applicable for culinary, medicinal and cosmetic products. A good selection of products will also broaden the appeal to consumers and potential customers.

One metric ton of seaberries will yield the following raw products in approximate quantities:

- 800kg of puree/juice
- 30kg of pulp oil
- 8kg of seed oil
- 85kg press-cake
- In addition, leaves and branches will be bi-products of the harvesting process

The juice is self-explanatory and is the basic ingredient for many products. It can be found as a pure juice, sweetened, blended in combination with other fruits, in smoothies, nectars and cordials. It can also be used in ice creams and sorbets, equine health supplements, in liquors, dressings, vinegars, jams and jellies and in confectionery.



Both oils are rich in omega oils otherwise known as Essential Fatty Acids (EFAs). These have applications in skincare and general healthcare products. Generally, seed oil is better taken orally for health purposes and the pulp oil is used topically. However, a manner of combinations is used.

The process to extract the juice and oil from the seaberries produces press cake. It is a good source of protein containing 15-20%. It can be dried down and ground to make a high protein powder for use in protein shakes, smoothies, on breakfast cereals or in bakery products such as granola bars.

Indian research on feeding sea buckthorn press cake to cattle showed improved daily live weight gains combined with a reduction in methane emissions.

The silvery-green leaves of sea buckthorn contain a similar nutrient profile to the seaberry. The leaves are high in polyphenols and can be used to make a healthy tea.

Branches can be chipped, composted and used for fertiliser. Alternatively they could be burnt and used as an energy or heat source.

In addition there has been a modest demand for using entire seaberries as a garnish in restaurants. It offers a colour explosion on a dining plate and its tart flavour is very complementary to seafood.



Figure 8: A tasty glass of sea buckthorn smoothie, Germany, 2015



4.5: Global production figures

The table below shows the estimated area under commercial production worldwide. For the purposes of the list, commercial is defined as a sea buckthorn orchard specifically planted for fruit production. This will therefore preclude such countries as Nepal, Bhutan, Iran and India where the foraging of wild sea buckthorn facilitates production.

I will also reiterate that these are estimated areas only and that a large deviation from actual areas is entirely possible.

Country	Area (Ha)	Country	Area (Ha)
China	600,000	Mongolia	300
Russia	2,000	Poland	150
Estonia	850	Italy	150
Germany	600	Sweden	50
Finland	500	U.S.A.	50
Latvia	450	U.K.	15
Romania	400		
Canada	300		

Figure 9: table to show estimated area of sea buckthorn under commercial production worldwide

4.6 Production economics

I don't wish to dwell on this subject for too long as in reality it is very subjective indeed. Nevertheless it is, of course, an important topic to consider. As with all UK fruit production, costs here are comparatively higher than those found elsewhere in the EU and indeed the world.

Higher labour, fuel, energy and land costs all combine to add extra pressure to profitability. However, we do have 63 million sales opportunities in the country and they are becoming increasingly health conscious with a growing appetite for healthy products.

Domestically produced sea buckthorn would initially achieve a niche market status. However, as the market develops, foreign competition will be quick to take advantage of any new opportunities.

Suffice to say that producing sea buckthorn fruit as a commodity will be a risky venture and margins will inevitably be under constant pressure from imports or subjected to market volatility. There's currently a strong demand for raw product on the continent. However, the margins are unlikely to be large enough to justify the necessary investment required in producing a commodity crop.

Maximum income from sea buckthorn is split between approximately 38% from food and drink products and 59% from pulp and seed oil. Capturing or adding value to the seaberries by processing them into a range of different products will be integral to delivering sustainable profits.

To ensure profitability and longevity for a British sea buckthorn business enterprise, the main principle is to deliver an exceptionally high quality product, through a robust brand. Added value through processing will be of significant importance. It will also be especially important to promote the provenance and quality aspects as a point of differentiation.



4.7 Health credentials

This is where things get exciting and you can gain an understanding of what this fruit has to offer us. To date some 190 bio-active compounds of sea buckthorn have been discovered and it has been categorised in them. It is widely regarded as a functional food, defined as: a conventional food which is consumed as part of a usual diet and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional function. (BNF:2016).

I attended the 7th conference of the International Sea Buckthorn Association in New Delhi, 2015. I was astounded by the range and depth of scientific papers and research into the health properties of this fruit. Unfortunately much of this information isn't widely disseminated into the western world, so it escapes under the radar. Also, because big-name companies and research institutes haven't conducted the work, then it is sometimes very unfairly belittled. A casual Google search of health attributes of sea buckthorn will deliver a wealth of researched results. The depth and detail of the papers entered a realm far beyond my scientific understanding, but suffice to say they're very interesting indeed.

As with all natural products, an analysis of fruit will be highly variable and will fluctuate between varieties, seasons and production methods. For sea buckthorn, fruit grown in the most stressed location e.g. at altitude, tends to have the highest antioxidant levels. The high vitamin C content is often quoted as being 'ten times that of oranges'.

I had some initial reservations that sea buckthorn grown at sea level in Cornwall would fall short of the mark in terms of its analysis. However samples from my modest harvest in 2015 when tested had a vitamin C content of 148mg per 100g - that's almost 300% of the reference value for oranges.

The best health-beneficial attributes of sea buckthorn, those that make it a functional food, are the high antioxidants and omega oils content. At the 2015 Food Matters Live conference, I arranged an appointment with Liz Tucker, a registered nutritionist, to get myself informed on these health aspects.

The term 'antioxidant' is now a widely understood and used word, but this has only happened in recent years. As our cells go about their natural processes they create waste molecules, known as free radicals. These are missing an electron, making them incomplete and volatile. Consequently, they seek to complete themselves by reacting with any other molecules. The act of pinching an electron causes oxidation damage to other cell components such as fat, protein and DNA. Detrimental effects can accumulate as a result, making the cells more susceptible to disease.

The good news is that antioxidants occur naturally in our bodies. They block damage by donating electrons to stabilise or neutralise the adverse effects caused by the free radicals. The bad news is that even though most free radical damage is repaired, a proportion still remains. Additionally, our daily environment exposes us to a number of sources of free radicals such as air pollution, wifi, mobile phone signals and UV radiation to name just a few. This is why we need extra antioxidants.

An Oxygen Radical Absorbance Capacity (ORAC) rating measures antioxidant performance in fruit. The United States Department of Agriculture determines ORACs per 100g of fruit and recommends a daily intake of around 5000 ORAC units. Most people, though, only manage 1000. (Runestad:2009). The ratings for fruit on an ORAC chart will be subjective and there is some wide deviation in data. Some



bold and probably unsubstantiated claims are made for marketing purposes. One source puts sea buckthorn at an ORAC of 70,000 compared to 102,000 for acai berries and 9,500 for cranberries.

Whilst specific ORAC ratings might vary depending on which source you are reading, it's indisputable that antioxidants are good for our health (the more the better) and sea buckthorn provides a comprehensive source of antioxidants.

Another unique property belonging to sea buckthorn is its full complement of omega oils, otherwise known as Essential Fatty Acids (EFAs). Our bodies can manufacture most of the fats they require from our food. EFAs are slightly different in that the body cannot synthesise them, therefore it is essential that they can be obtained from food. Deficiencies in EFAs can lead to all manner of problems with daily bodily function and health, a list that is too lengthy to mention here.

Omega 6 (linoleic acid) and omega 3 (alpha-linoleic) are the two most important EFAs. It's obviously important to ensure that we have sources of these EFAs in our diets. Furthermore, we need to be getting the right balance of both. Scientists and nutritionists consider a ratio of between 1:1 and 5:1 omega 6:omega 3 to be optimal. Unfortunately we generally have excessive quantities of omega 6, at the expense of omega 3; a ratio of between 10:1 to 20:1 is the average. This is largely due an increased use of vegetable oils (omega-6 dominant) and grain-fed livestock (altered meat profile).

Without getting too scientific, omega 6 and 3 compete for tasks in the body. If there's an abundance of linoleic acid this suppresses the alpha-linoleic. Omega 6 is inflammatory whilst omega 3 is neutral. With omega 6-dominated diets our bodies become an inflammatory environment and this increases the risk of inflammatory problems, cardio vascular disease being one of many.

Where does sea buckthorn fit in with all of this? Seed oil from sea buckthorn is very high in EFAs. Up to 70% of the oil is comprised of Omegas 3 and 6. It also has omega 9 (oleic acid) in there too. Of the omega 3 and 6, neither is dominant: they tend to stay equal around the optimal 1:1 ratio.

Sea buckthorn pulp oil contains omega 7 (palmitoleic acid), something no other fruit can offer. Omega 7 is normally found in fish. Sea buckthorn is one of only a few plant sources, macadamia nuts being another, although the quantity in sea buckthorn is much higher. The benefits of palmitoleic acid are commonly associated with our body's biggest organ - the skin. Omega 7 hydrates, heals and protects the skin. There are internal benefits too; omega 7 assists overall health of the immune system, with digestive function, it fights and heals gastric ulcers and aids mucous membranes all over the body, even our eyes.

The table *on next page* lists just some of the healthy properties of sea buckthorn and some of the associated health benefits. It's not an exhaustive list by any means, but a mere indication of the vast potential that the fruit offers.

see table on next page



Properties:	Health Benefits:
Vitamins A, C, E	<ul style="list-style-type: none">○ Anti oxidants○ Fight cell-damaging free radicals○ Supports healthy cell reproduction○ Anti aging benefits○ Supports health skin and hair○ Healthy functioning immune system○ Helps wounds heal○ The body cannot store vitamin C so it is required daily
Vitamin B	<ul style="list-style-type: none">○ Beneficial to skin and eyes○ Supports healthy brain and nervous system○ Helps the body to release energy from foodstuffs
Vitamin D	<ul style="list-style-type: none">○ Keeps bones and teeth healthy by regulating calcium and phosphate in the body
Vitamin K	<ul style="list-style-type: none">○ Helps blood to clot○ Important to help wounds heal
Carotenoids	<ul style="list-style-type: none">○ Slow the aging process○ Support eye health○ Support prostate and colon health○ Anti-oxidant
Flavonoids	<ul style="list-style-type: none">○ Help to fight cell damaging free-radicals○ Assist in healthy cellular regeneration○ Promote healthy immune system○ Can assist in lowering cholesterol○ Anti-oxidant
Minerals	<ul style="list-style-type: none">○ Help the body produce energy○ Support growth in the body
Anti-inflammatories	<ul style="list-style-type: none">○ Support healthy cardio-vascular system○ Relieve sore joints
Protein	<ul style="list-style-type: none">○ The 'building blocks of life': every single cell contains protein○ Our bodies use protein to fix old cells and generate new cells
Omega Oils 3,6,7,9	<ul style="list-style-type: none">○ Support healthy cardio-vascular system○ Sustain brain and nervous system functionality○ Healthy skin and hair○ Promote healthy digestive system○ Healthy mucous membranes○ Essential for normal cell function○ Our bodies can't make all these essential fatty acids (EFAs)

Figure 10: Health characteristics of sea buckthorn (Source: author)



Chapter 5.0: Sea buckthorn agronomics

As an agronomist myself, I find all the intricate details around growing different crops absolutely fascinating. I could very easily ramble on and type many, many pages on sea buckthorn agronomy. However, my Nuffield Farming study is not solely about sea buckthorn agronomy and consequently this report should not become a cultivation handbook.

To all intents and purposes, the methodology for growing any crop - from wheat to wild rocket - is broadly similar. It is learning the pivotal influential aspects specific to an individual crop or species, that differentiates things. Explicitly concentrating agronomic advances on these attributes are where big gains can be made in terms of yield and quality.

A second important point to remember is that it's all well and good being able to grow a crop, but one mustn't lose sight on the fact that you have to be able to sell the crop too. See case study two below.

In this chapter I hope to draw attention to, and provide some information on what I consider to be challenges, opportunities and matters of agronomic importance for sea buckthorn.

Case Study Two: Tregothnan Tea Finding the balance between production and marketing

Jonathon Jones (NSch: 2001) is the Managing Director of Trading at the Tregothnan Estate near Truro, Cornwall. After completing his Nuffield Farming Scholarship study, Jonathon started growing tea bushes (*camellia sinensis*) on Lord Falmouth's estate.

Initially challenged with 80% plant mortality, he persevered and went on to successfully establish a tea plantation. The Tregothnan Estate is now widely renowned as the only domestic tea producer and has an excellent reputation as a premium, luxury tea brand.

There are similarities between what Jonathon has achieved and what I aspire to achieve. Other camellia species thrive in the UK, but nobody had successfully produced tea. Similarly, whilst sea buckthorn grows wild in the UK, it is relatively new as a commercial crop.

The single biggest difference is that almost everyone knows what tea is and almost everyone drinks it. We drink around 165 million cups of tea each day in the UK (UKTIA:2016). Tea inevitably has a large established market. The same cannot currently be said for sea buckthorn.

Jonathon's advice was to stay market-focused. When I pushed him to be more specific, he declared that at any given time his efforts are concentrated on marketing (70%) and production (30%). Even during peak production moments such as harvest he is always at least partially thinking about marketing (40%) and not solely production (60%).



Jonathon encouraged me to “*get out of the grower mind frame*”. This was perhaps one of the most prudent pieces of advice I received on my Nuffield Farming Scholarship. I find that I am continually reminding myself of his wise words.

5.1: Genetics

As sea buckthorn is a relatively minor crop worldwide, its commercial value pales into insignificance when compared with the billion dollar industries of comparable healthy fruits such as cranberry, blueberry and pomegranate. Understandably, plant breeders have focused their efforts on more lucrative crops where a return on investment is more readily realised.

Despite this there are several sea buckthorn breeding programmes in operation worldwide. The oldest is the Russian Lisavenko Research Institute of Horticulture in Barnaul, Siberia. Breeding has been ongoing since 1933, and 40 commercial varieties have been launched. Siberian varieties tend to have the following attributes on female plants:

- Fewer, smaller or complete absence of thorns
- Exceptional winter hardiness
- Larger individual berries
- Longer peduncles
- Sweeter tasting fruit
- Berries are more of a red or red-orange in appearance

Siberian varieties are well suited for production across Eastern Europe, China and in North America. In the UK, and in such locations where milder winters are more common, the dormancy of Siberian cultivars can be negatively affected in the formative years. However once adapted, the varieties seem to perform well (*Eagle: 2016*).

One of the first varieties ‘*botanicheskaya lubitelskaya*’ was bred at the Moscow State University botanical gardens. I’m told that this translates to ‘*botanical-lovely*’, yet Google translates it to ‘*botanical amateur*’! It is thought that the ancestry for most of the commercial sea buckthorn breeding lines derives from, or originated with, Russian cultivars.

Mr Hans-Joachim Albrecht started the German sea buckthorn breeding programme in 1990. Six commercial female varieties have been successfully bred. German varieties are high yielding. They tend to have a very vigorous and regenerative growth habit, making them well suited towards an aggressive harvesting style, discussed later in this chapter. German varieties generally have a very bright orange or yellow-orange fruit that tends to have a more astringent taste. They have reasonable winter hardiness (-20°C), but aren’t hardy enough to endure severe winter temperatures.

At the Swedish University of Agricultural Sciences in Balsgård, Sweden, breeding of sea buckthorn has been underway since 1985. I met with Kimmo Rumpunen the plant breeder and he showed me around the orchard. Interestingly, Kimmo is breeding and selecting varieties based on taste as the primary criteria. The site is broadly at just above sea level and is just 15 miles from the Baltic Sea. Whilst the light intensity and seasons might differ slightly (they would get longer, brighter summers, but colder,



darker winters) I would expect the Swedish varieties 'Lotta' and 'Sun' to do well in the UK.

The Canadian sea buckthorn breeding project is managed by Agriculture and Agri-Food Canada (AAFC). The breeding strategy is aimed at improving yields, fruit characteristics, harvest efficiency and thornlessness. Good progress has been made since the program started in 1995.

China's breeding programme is more concentrated around the sub species *hippophaes rhamnoides ssp. Sinesis*. This species is better suited to the growing conditions found in China and used in vast quantities for conservation purposes. This species produces a smaller berry and one that is highly astringent. Although vitamin C levels are much higher, it is to an extent where the berry becomes unpalatable for the typical western palate.



Figure 11: Different sea buckthorn varieties at a plant raiser's near Hamburg, Germany 2015

Another interesting development in Germany is grafting, which is being spearheaded by Dr. Friedrich Höhne. Rootstock from varieties with good resistance to the soil borne diseases verticillium wilt and fusarium are selected. Then females with desirable fruiting/plant characteristics are grafted onto them. The research is at a relatively early stage, but it's interesting and shows good potential.

The Latvian varieties were seemingly the best combination of yield and taste that I encountered on my trip. Many of these have been bred by Andrejs Brūvelis who is the chairman of the Latvian Sea Buckthorn Association. 'Mary' was one variety that caught my attention: it has a long harvesting period of 20-25 days, which offers good flexibility for harvesting logistics and planning.



Near Arad, Romania, Alexandru Vulpe reputedly has the largest sea buckthorn nursery in Europe. Alexandru believes that daylight hours and light intensity can significantly affect the cultivar's performance and behaviour. His main selection criteria are fruit taste and colour, vitamin C content, maturity (early/late harvest) and of course yield.

Male sea buckthorn plants don't get quite as much attention from breeders as the females. This is largely because the main role for the male plant is to provide prolific amounts of pollen that is synchronised with the flowering time of the female plants.

Normal male inclusion in an orchard is between 8-12%. It is important that male cultivars persist in commercial plantation; poor pollination will reduce fruit yields if the males are unhealthy or absent. Male plants are generally selected on plant vigour, persistence and timing of pollen dispersal. It is common for growers to use more than one variety of males, ideally with different duration of pollen production to extend the window of pollination for the female plants.

Sea buckthorn breeding is still in its infancy. Selection criteria relate to berry size, yield, plant habit and fruit composition. Some varieties have better tolerance to soil borne diseases than others, but often yield or fruit quality is compromised or less desirable. However, it is very encouraging that there are a number of breeders in Europe as these varieties will all be suitable for use in the UK.

5.2: Invasive potential

The majority of "bad press" sea buckthorn receives is about its potential to be an invasive species. It is well documented that in a sand dune habitat sea buckthorn can become invasive and problematic unless intervened with and control measures taken. In the UK where the plant has been used for conservation purposes on sand dunes it has flourished and consequently become a problem itself.

In 2013 the Republic of Ireland listed *hippophae rhamnoides* as an invasive species. It is categorised as follows: "Amber list: recorded species. Uncertain risk. Species are rated as medium risk due to the score of the overall assessment. However, their impact on conservation goals remains uncertain due to lack of data showing impact (or lack of impact)". (ISI:2016).

There's little doubt that it has an ability to spread. Sea buckthorn is a surculose² plant; where a natural growth habit is spreading via rhizomes and suckers. However, it is important to put all of this into context.

As sea buckthorn is a pioneering plant, it has an ability to grow in areas where other plants cannot. Let's take the example of a sand dune habitat, where it thrives. A sea buckthorn population establishes on a dune. As seasonal growing cycles pass by, dead leaves and branches accumulate and create organic matter in the sand below. The *frankia* bacteria fix nitrogen in the rooting zone. Perhaps a bird visits the tree and deposits weed seeds in its droppings. For the purposes of this example let's say it contains chickweed, docks, or a fescue grass. All three are nitrophilous species that can grow in many situations. The plants establish and thrive on the readily available nitrogen. In turn insect activity increases the biodiversity and other plants establish. The sea buckthorn plant is now in a situation where it has to compete – something it does not like to do. Detecting the competition the sea

² Having numerous branches arising from near the base: producing suckers



buckthorn puts energy into sucker production to move away from the competition and to pioneer a new area of the sand dune.

Sea buckthorn is a native species in the UK. In its long history here I am unaware of and cannot find evidence to document any invasion of woodland or agricultural land. In fact, away from the coast, one could easily consider the plant to be rare.

In a commercial orchard scenario suckers are an undesirable trait as it is thought that they distract plant energy away from fruit production. Where they exist, mowing and grazing are the management tools used to control suckers.

The other potential form of spread is via seeds after ingestion by birds and small mammals. It is reported that seed that has passed through the gut of a bird is six times more likely to germinate. However, seedlings require high moisture and humidity to germinate. The seedlings do not tolerate any competition or shading whatsoever. Furthermore, young seedlings tend to be very attractive to rabbits and other casual grazers. Therefore, overall likelihood of seedling survival, whilst not impossible, is considered unlikely.

5.3: Harvest

Harvesting sea buckthorn poses perhaps the most significant challenge or hindrance to a commercial enterprise. This is considered to be the main constraint preventing a wider uptake of the crop on a large-scale commercial basis. The current inability to develop a cost effective and efficient harvesting method can have negative repercussions on the economics of the crop. Labour intensive harvesting procedures can often represent between 50-75% of the overall growing costs.

The normal window of opportunity for seaberry harvest lasts for around a fortnight. Growers can use earlier or later maturing cultivars to extend the harvest period and spread the risk. However, the general requirement will still exist for the harvest to be as timely and efficient as possible.

The fruit of sea buckthorn is not a true berry, as there is an absence of an abscission point on the fruit. Consequently, seaberries cling onto the peduncle and do not separate easily. The growth habit of the plant is for fruit to grow in tight clusters close to the branch. In addition, most varieties have a series of aggressive thorns, adding obvious challenges to the harvesting process.

Hand harvesting is painfully slow. Let me rephrase that – from personal experience hand harvesting is both painful AND slow. Typical work rates are impractical at 1-2kg per person, per hour. This is variety-dependent though. On thornless Siberian varieties with larger fruits, much higher output is reported.

In the UK there is a dedicated and devoted gang of foragers out there who will persevere with hand harvesting, particularly up in Scotland. Other hand-draulic harvesting methods include directly squeezing the berries on the branch and collecting the juice. Again this is sufficient on a small scale, but wholly unfeasible on a commercial enterprise.



In India the favoured harvesting technique is to place a tarpaulin beneath the tree and then beat the branches with sticks until the berries fall off. The collection from the tarpaulin then gets taken to a processing plant for separation and purification.

Vacuum harvesters use a combination of a comb and vacuum to persuade the seaberries off the branches. It's still a very labour intensive process and requires a tractor and 6-7 staff to run, but outputs of up to 1000kg/day are achievable. Again, this is variety-dependent and not particularly well suited to varieties that have short peduncles with seaberries close to the branch. When berries burst during the harvest procedure, a layer of juice forms on the internal wall of the suction hose, attracting detritus and further reducing efficiency.

Another method is vibration harvesting, where the seaberries are shaken off branches by vibrating arms, either attached to the trunk of the tree or to individual branches. Removal success is between 50-60% so the process isn't particularly efficient. In addition, the clamps can cause severe and undesirable damage to the bark of the trees.

Some interesting work has been conducted on the use of hormone treatments to enable seaberry release from the branch. A pre-harvest ethylene treatment encouraged the formation of an abscission layer on the berry and facilitated a more efficient harvest (*Demenko and Korzinnikov: 1990*). Strict legislation on Maximum Residue Levels (M.R.L.s) might negate any chance of this becoming a reality in practice. Furthermore, significant data would be required and the cost attributed to doing so would be prohibitive for such a minor crop as sea buckthorn.

In Latvia, Andrejs Brūvelis is conducting some really interesting work on manipulating the architecture and canopy of the sea buckthorn tree to facilitate an annual harvest. Two approaches are being trialled: vertical split and horizontal split. The vertical split divides the tree into two halves, with one side a year older than the other. Harvesting alternates between each side on three-year-old branches, as they are much higher yielding. Two years of harvest are followed by one year of rejuvenation.

For the horizontal split, dormant branches are pinned down to the ground in arches at the start of the season. The plant is then stimulated to grow upward-leading shoots from these branches. Meanwhile the older pinned 'arch' branch flowers and sets fruit. Effectively the top half the tree is vegetative and the bottom half is reproductive or generative. The fruit laden branch is harvested, but the young upward shoots remain. The process can then be repeated the following spring.

Currently the most successful and feasible harvesting process for sea buckthorn on a commercial entity, is the 'cut and freeze' technique. Fruit laden branches are mechanically or hand pruned from the tree and then frozen. Using a relatively simple vibration cleaner, frozen seaberries are then rattled off the branches and separated from admixture to produce a clean sample.

See photo on next page

The mechanical cut and freeze method delivers approximately 80% removal of fruit, with 20% of the seaberries left on the plant below the cutting blade. Manual pruning could perhaps offer increased removal efficiency, but obviously output would not be comparable (unless a large labour force was used). It is also important to note that varieties aren't all suited to this aggressive harvesting method. Some foliage has to be left on the plant to ensure energy is still transmitted into the plant to encourage healthy re-growth the following season.



Figure 12: Harvesting in Quellendorf, Germany 2015. Note the amount of seaberries left on harvested trees.

There are disadvantages to this approach. Prune-harvesting all or most of the berries removes the branches. As fruiting generally occurs on two-year-old wood, by default you are removing the potential for a harvest the following season. Therefore, you effectively halve your yield potential as you can only harvest every second season. To circumvent this, growers split the orchards into two halves and alternate each harvest between the two. An alternative would be to hand prune fewer fruit yielding branches so that the tree can sustain production the following season. This is the common approach for varieties that cannot sustain an aggressive cut technique. Whilst yields are compromised, an annual production is maintained. Another big disadvantage is that it necessitates sizeable investment in suitable freezer capacity and primary processing equipment. The size of the freezer will be the limiting factor on harvest output.

5.4: Sea buckthorn fly

Sea buckthorn fly (*rhagoletis batava*) is potentially the single biggest nemesis threatening commercial fruit production of this crop. Infestations can decimate berry yields, with complete crop loss frequently reported. The fly is thought to originate from Siberia. The Altai Krai is the main sea buckthorn growing region in Siberia. Some growers have been forced to abandon cultivation of sea buckthorn due to the prevalence of the fly (*Shamanskaya:2015*).

The fly belongs to the *tephritidae* family. This is one of two fly families commonly known as fruit flies, the other being *drosophila spp.* The *rhagoletis spp.* genus contains around one hundred species. The cherry fruit fly *rhagoletis cerasi* is the most economically important species in Europe and incidentally looks very similar to the sea buckthorn fly.

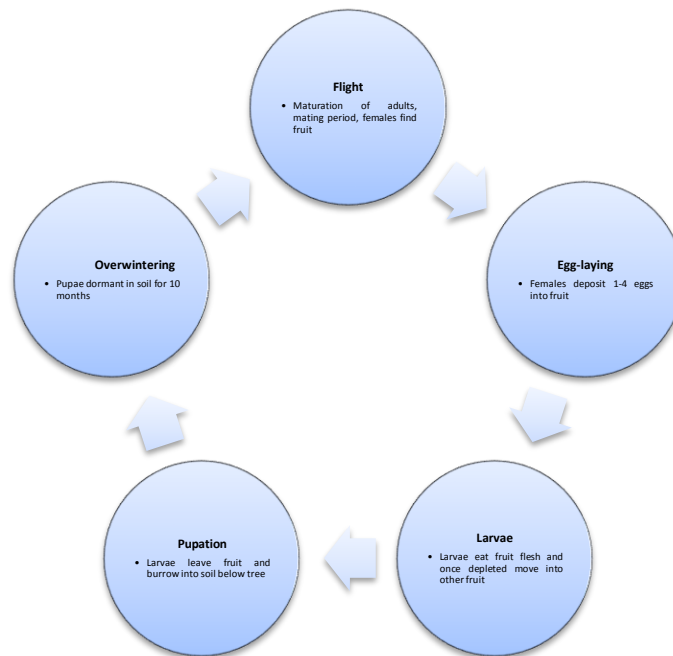


Figure 13: A basic summary of the *ragoletis batava* lifecycle

The fly has gradually spread west from Siberia into Eastern Europe and south towards Mongolia and China. Sea buckthorn fly has become particularly problematic in the Baltic States where it now seems to be an annual issue. Certainly this is where I learnt most about the pest and the growers seemed the most concerned. However, commercial crops in Scandinavia, Poland, Romania and Germany have all suffered severe damage in recent years.

In China the extent of fly damage is currently less prevalent. It is thought that the fly hasn't yet adapted to the climate. Another hypothesis suggests that as the area of wild sea buckthorn in China is so enormous, the fly might not yet have encountered a commercial production site. Nevertheless, the Chinese growers are being vigilant by monitoring for fly activity in commercial crops, taking heed of the warnings from their Russian correspondents.

In Latvia I met with entomologist Dr Artur Stalazs. He informed me that the sea buckthorn fly is regarded as oligophagous; meaning there aren't many/any alternate host plants. As there is a wild sea buckthorn population across the British Isles Artur thought it likely that the fly would already be present here, but perhaps a small population only.

Artur manages a trapping programme across northern Latvia. He places yellow-sticky flytraps in both wild and commercial populations across the region and monitors the traps for adult sea buckthorn flies. Once flies are present on the trap it indicates that pupae have hatched and the risk period has started. The quantity of adults caught on the traps gives guidance on the extent of the population and can be used as a tool to provide thresholds for insecticide treatments.

In continental Europe and further afield there are insecticide products approved for use on sea buckthorn. These approvals are often extrapolated from data on other fruit and berry crops. Typically the modes of action used are pyrethroids and neonicotinoids. Both are moderately successful when applied in a timely manner. Neonicotinoids have a systemic mode of action, where the active



ingredient can translocate through the plant. Consequently they are more persistent and one would expect greater efficacy from its use compared to that of a contact type pyrethroid insecticide.

The future of neonicotinoids is jeopardised and they are under considerable pressure for withdrawal from lobbying groups. Regulators are examining claims that the insecticide group is responsible for a decline in bee populations.

In the UK there are currently no insecticides approved for use on sea buckthorn. As it's currently such a minor crop, obtaining an approval could be difficult with prohibitive costs involved.

There is some anecdotal evidence that susceptibility to the sea buckthorn fly can vary between cultivars, with some varieties showing less infestation than others.

One possible explanation for this is the plant maturity. Earlier varieties tend to be more susceptible to sea buckthorn flies. The berry is more developed around the time that the adult sea buckthorn fly takes flight. It therefore becomes more attractive as an egg-laying site. On later varieties the fruit would not be present or advanced enough to present an egg-laying opportunity for the fly.



Figure 14: A trapped adult *Rhagoletis Batava*. Body 4-6mm, wingspan 7-9mm. Latvia, 2015

Another theory is that the variation of fruit composition between varieties can also influence the susceptibility. This is certainly true for the cherry fruit fly. Observations made during oviposition (egg-



laying), show females responding to visual markers such as fruit colour, size and shape. Once the fly lands the female walks in circles exploring the fruit to determine size, shape, softness, before then deciding whether to oviposit (*Daniel C, Grunder, J:2012*).

Sea buckthorn breeding efforts in Russia are focused on finding a truly resistant cultivar. However Russian varieties don't necessarily thrive in all climates. Therefore resistance to sea buckthorn fly should be an integral objective for all worldwide breeding programmes.

There are a whole host of biotic and abiotic environmental factors that also affect the degree of fly activity. Rainfall during the main flying period can result in a substantial reduction in pest incidence. Similarly a severe spell of ground frost can cause significant mortality to dormant soil pupae.

Larvae numbers can be as high as 1000/m². It is thought that around 90% of larvae perish when they leave the fruit and move into the soil to pupate (*Shamanskaya:2012*). Up to 70% are killed by predation from parasitoids and other soil insects and/or mammalia amongst the orchard.

Cultural control methods such as leaving long vegetation below the fruit trees or the use of physical barriers like mulches/plastic to prevent the larvae entering the soil will be advantageous to control. A further 20% mortality is realised from pupae fungi, diseases and environmental conditions.

5.5: Agro-forestry

The layout of a commercial sea buckthorn orchard is broadly similar to most other commercial fruit tree crops. Typically grass or chem-fallow avenues are established between the rows of fruit trees, enabling access for crop husbandry and harvesting procedures to be conducted.

The area of land between the fruit trees can be considerable on a large orchard. Routine maintenance of these areas by mowing, cultivating and spraying can accumulate significant costs each season. In the case of chem-fallow, where routine spraying with broad spectrum herbicides is used to control vegetative growth, these access strips are also vulnerable to soil erosion and degradation.

There is no return on investment for expenditure on the land between the fruit trees, as it doesn't directly generate any revenue. However these areas are an integral part of orchard system, a necessary evil perhaps. Indeed these areas, whilst sizeable, are often under-utilised and under-appreciated.

For fruit enterprises, initial capital costs to establish an orchard are significant. This money is spent up-front and there is no income generated for a number of seasons while the orchards are established. For sea buckthorn it takes as long as five years before the trees reach maturity and fruition.

Therein lies the opportunity for agroforestry; an income generating enterprise that can co-exist with, or is complementary to young establishing fruit trees. This would be especially advantageous for cash-flow generation in the formative years of the orchard.

There are two immediate tangible benefits. Firstly it can provide income generation; short season crops realise a speedier turnover of cash than sea buckthorn or other orchard fruit crops. This can help to offset or subsidise orchard establishment. Secondly intercropping capitalises on what is essentially wasted ground.



Then there are of course the less quantitative benefits to consider. Agroforestry can improve overall biodiversity, nutrient cycling and soil biological activity. Simultaneously agroforestry can reduce soil erosion, nutrient leaching and offer some protection from extreme weather events (ART:2016).

In China I visited a young sea buckthorn orchard where the growers were intercropping vegetables in-between the rows of sea buckthorn. The orchard was in the establishment phase, so access to the trees was not essential. The growers were capitalising on the spare ground by growing marrows as a cash crop. The trees provided the marrows with shelter from fierce local winds and nitrogen from the *frankia* bacteria. Agro-forestry provided the farmers with an income source before the sea buckthorn reached fruition.

It was astounding to see such healthy crops growing on what appeared to be pure desert sand. I learnt that all crop production in that particular region was supported by irrigation from the Yellow River. With an annual rainfall of just 280mm if the irrigation water stopped, then the region would rapidly revert to barren desert.



Figure 15: Inter-cropped marrows in a young sea buckthorn plantation: note sandy soil and irrigation pivot in background. Ordos, China 2015

In Latvia I met with Inguna Zukure a strawberry and sea buckthorn grower. Inguna has a local reputation for producing very tasty strawberries and above-average sea buckthorn yields.

Inguna concluded that the land between the sea buckthorn trees was being wasted and decided to intercrop strawberries. Results were mixed; fruit yield was often higher, but of lower quality. The benefit to the strawberries from the nitrogen fixing bacteria was visible, but this also meant that the grass and weeds were more competitive too. Access for crop husbandry on either crop was also compromised.

In theory one could extend the distance between the rows of trees and accommodate perhaps one tramline width of broad acre crops to be cultivated in the area. However there may be some concerns with pollination for the sea buckthorn enterprise and the percentage of male trees may need to be increased. Again access to either crop could be compromised.



Figure 16: Intercropping strawberries between sea buckthorn trees, Latvia 2015

Personally I am looking to reduce management time and expenditure spent on maintaining the grass strips in the orchard. Intercropping with cash crops doesn't particularly fit the brief as it necessitates significant additional input costs and increased management time. Essentially what I was after was a self-propelled, semi-automated grass cutter. Apparently these are more commonly known as sheep.

I learnt that Innovative farmers had an on-going field lab study, "maximising potential of the understory in orchards". This involved the grazing of sheep amongst apple orchards. Specifically, it related to one particular breed of sheep - the Shropshire.

Elsewhere in Europe this breed is sought after for grazing in amongst Christmas tree plantations. For the most part the sheep opt to stick to grazing the grass amongst the trees rather than the trees themselves, making the breed a suitable candidate for this trial. I joined an interesting group meeting in Herefordshire where several aspects of orchard grazing and the management thereof were discussed.

Part of the Duchy Future Farming Programme, Innovative Farmers, is backed by a network including the Soil Association, Linking Environment and Farming (LEAF), Innovation for Agriculture (IfA) and supported by Waitrose. It enables practical problem solving via trialling, testing, discussion groups and hands-on research, resulting in lasting solutions. (*Innovative Farmers :2016*).

Admittedly sea buckthorn is very different to both fir and apple trees. Nevertheless the principle is still the same. I concede that the husbandry of a small flock of sheep will still require reasonable management time. However this approach is a much more carbon neutral method of keeping the grass cut between the trees. I consider this to be the most appropriate agroforestry system for my own circumstances. Therefore once my trees are robust enough to handle it, I shall trial some Shropshire sheep in amongst the trees.



Figure 17: Shropshire sheep grazing amongst a traditional apple orchard, Herefordshire 2015.
Photo credit Innovative Farmers



Chapter 6.0: The marketing mix

This is perhaps the most important consideration of all for the future of sea buckthorn. Philanthropic gestures towards improving public health aren't much good in a business sense.

The term "superfruit" appeared in the early 2000s and was used to differentiate fruit that seemingly exhibited particular potential for health benefit. It used science to validate these health benefits and in turn enabled marketers to make convincing claims. There is a positive correlation between the amount of scientific studies published about a fruit's health attributes and its status as a superfruit.

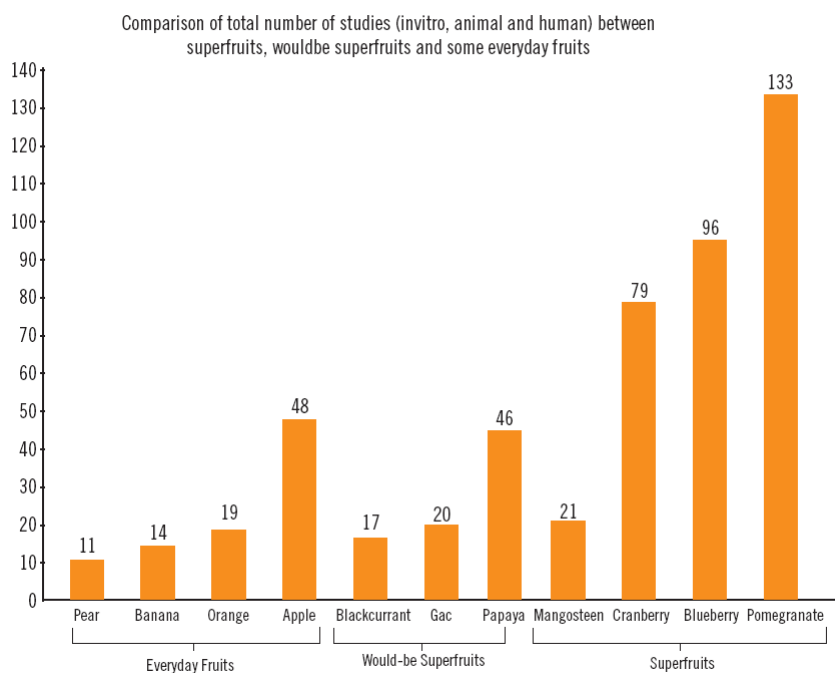


Figure 18: Comparison of total number of studies (invitro, animal and human) between superfruits, would-be superfruits and some everyday fruits

Source IMI:2008

Scientific research papers don't come cheap though. They are a tool to aid marketing, where appropriate, but they also need to deliver a return on investment. Does the science enable the market? Or do marketers wait and see which new fruit products are up and coming and fund the research in order to develop the market?

Substantiated health attributes are integral to establishing an on-going relationship with consumers. Promoted by health experts, beauty experts and the media many formerly unheard-of fruits like acai berries, goji berries and aronia are now gaining much more attention.

Superfruits are becoming *passé* though. The industry was quick to capitalise on a rapidly expanding market and often unsubstantiated or negligible claims were made. This only belittled the word's credibility with the consumer and a natural degree of scepticism appeared. Strict legislation governing



what can and cannot be claimed on labelling has been introduced and is now enforced by the European Food Safety Authority (EFSA).

In 2015 the value of the berry market topped £1 billion for the first time in the UK. The fresh blueberry market grew by 20%, yet has barely reached 50% market saturation (*Northcroft: 2016*). Excuse the pun: but consumers clearly have a big appetite for healthy berries.

Another consideration is that of the organic marketing model. Admittedly sea buckthorn is well aligned with this ethos. However, the size of the organic market in the UK has been in decline since it peaked in 2008 (*DEFRA:2015*). One has to question whether selling the product as organic can recapture the additional operating restrictions and costly certification. It can't be ruled out though.

The public perception of a brand is very important to consumers. At our Contemporary Scholars Conference in France we were told "*People don't care what you know until they know that you care*" by Jean-Pierre Beaudoin, a communications expert. This has led to a rise in content marketing, where businesses develop an ongoing relationship engaging their consumers. An example of this is Innocent drinks. People subscribe to the brand's *modus operandi* and values. They will happily choose an Innocent Smoothie over that of a cheaper brand because they know that Innocent will donate 10% of their profits to charitable causes – a core value that the purchaser and brand share.

Continuous innovation is another marketing must. "*Eggs are eggs,*" Rebecca Tonks from St. Ewe Eggs told me when I visited. "*Innovation is key, if you stand still for too long – you get in trouble*". An example of St. Ewe Egg's innovations is their 'Boost The Roost' range. Hens are fed an enriched diet and produce eggs naturally higher in selenium - an element us humans don't get enough of.

Just as I was thinking that surely there is only so much innovation one can do with eggs, then along comes The Crackin' Egg Co. Simply cooking boiled eggs and serving them to us, at a premium, in brightly painted food-safe shell colours, nice packaging and a condiment. Yes, innovation is essential.



Figure 19: Marketable? My story with sea buckthorn all started here – the Himalayas, Nepal, 2012



Having a story that people can relate with is another marketing approach in favour. It makes it easier for them to identify with a business, making it more personable and less corporate. The story becomes the foundation stone and the narrative that underpins the culture of the entire business.

6.1 The case for healthy foodstuffs

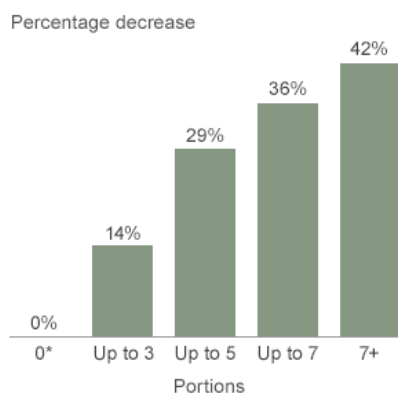
There has been a growing disassociation between food and nourishment. Each year we spend less and less of our disposable income on food.

Nowadays eating is something we just ‘do’ without consideration. We’ve become a snacking nation: eating whenever we’re hungry, but without a passing thought to nutritive value. Our lives are dominated with processed foodstuffs; high in added salt, saturated fats and sugars. If we’re not consuming them, then they are bombarding us in other ways such as advertising in magazines, billboards and websites etc. Coca Cola was the third most recognisable brand in the world in 2015 and one of only two food and drink companies in the top ten, the other of course being McDonalds (*Interbrand: 2015*). Bad food is big business.

Never before has there been such an abundance of cheap food in Western societies, yet our health as a nation continues to deteriorate. Geraint Hughes (*NSch: 2006*) hit the nail on the head when he said we are over-fed and yet under-nourished. Our inactive lifestyles and poor diet choices are taking their toll. There is a crisis in modern health care. Our NHS is burdened with ever-increasing patient numbers suffering from what are essentially self-inflicted diet/lifestyle related problems.

In spite of widespread recognition and familiarity with the 5-a-day campaign promoting daily fruit and vegetable consumption, most of us still only manage 3.5 portions on average (*DEFRA: 2015*). There

How fruit and veg intake reduces risk of death



*0 portions = 0%

Source: Journal Epidemiol Community Health

Figure 20: How fruit and vegetable intake reduces risk of death

are calls from University College London that the five-a-day scheme actually really ought to be a seven-a-day target. If that were the case, then currently we are only achieving 50% of the ideal.

In response to falling nutrition we have become accustomed to taking convenient vitamins and supplements to meet our recommended requirements. I would argue that this is still a cure approach rather than preventative by ensuring you eat a good daily mix of fruit and vegetables.

It's counterintuitive: why bother with something that has been artificially synthesised together in a factory somewhere, when you can get the real thing from fruit and vegetables – a synergistic combination of nutrients and vitamins produced in a natural environment. To quote Aristotle *‘the whole is greater than the sum of its parts’*.



6.2 Where is the UK market?

Whilst reading this report, perhaps the most obvious question that has crossed your mind is this – If the seaberry has such wonderful potential, then why hasn't the market already developed?

There are two probable explanations. If we examine where sea buckthorn has been successfully developed into big businesses, we discover that the main countries are China, Russia and Eastern Europe. These commercial enterprises developed behind closed borders during the Cold War years. As a consequence, investment was made inwardly, thus restricting progress within more traditional western markets.

Sea buckthorn research was not widely published on an international scale. Product development and promotion were specific to local markets. Enterprises were opportunistic in their nature, product led, without strategic brand development that would create consumer recognition and confidence.

With increased globalisation and border transparency the sea buckthorn community began to collaborate on an international scale. The International Sea-Buckthorn Association (ISA) was formed in 1995, with its objectives:

“To exchange international information of sea buckthorn and promote the research and development of sea buckthorn. To promote the utilisation of the plant to contribute to environmental protection, economic development and human health” (ISA:2015).

In countries where sea buckthorn has been around for decades, it is well known. People recognise its health-beneficial attributes, as it is intrinsically part of their culture. Familiarity goes a long way towards benefiting marketing. Rather than pushing products onto consumers and telling them about why they should be purchasing it, a much stronger position is if the consumer is already aware of the benefits and is drawn towards the product.

It does seem that the UK and USA were some of the last countries to become involved with, or aware of, sea buckthorn. In turn, consumer recognition and the market size are comparatively lower. Until fairly recently sea buckthorn product sales in the UK have been predominantly in online only, or specialist health shops, branding has been poor or non-existent. The market is now starting to gain momentum with sea buckthorn showing up in a range of on-trend products.

6.3: The category

An entirely new category - 'convenient health' - has emerged to satisfy a shift in consumer demands. It's fairly straightforward; products in the category provide healthy, convenient food and drink solutions to the modern cash rich, time poor, health conscious consumer. It's a strong category in which to strategically target or exist, as it appeals to a very broad audience and demographic.

A European survey on consumers reported that 75% believe a link between food and health exists. A further 79% thought diet was an appropriate method to reduce the likelihood of diseases. Of those surveyed, 62% frequently monitor their diets and are on the lookout for new products with health-beneficial attributes.



In the soft drinks category pure fruit juices hold the second place sub-category position behind Cola-type products. Juice drinking is no longer confined to the breakfast table or after sports. The convenient health category has widened the appeal of fruit juices to workplaces and on-the-go occasions such as the morning commute. People are motivated by health propositions on juice drinks. It's a fiercely competitive sector though. Product differentiation or value propositions to the consumer have to be clearly identifiable to justify paying a premium.

The challenger brand Innocent Drinks launched in 1999 and cleverly aligned its products to identify itself with an increasingly health conscious, ethically aspiring and hectic consumer. The business experienced rapid growth. Despite encountering some difficulties and setbacks during the 2008 recession, its strong branding and loyal customer base ensured they were able to bounce back.

Another excellent example of a convenient health category brand is the restaurant chain Leon. Established in London it has grown rapidly from one outlet in 2004, to over forty in 2016. They offer ethically sourced and healthy fast-food alternatives to those offered by the likes of McDonalds et al.

There are many similarities between sea buckthorn and cranberries. Both are quite tart berries that are better received by consumers when processed. The cranberry market is a multi-billion dollar one, figures that sea buckthorn can only aspire to. I visited Gary Garretson at his cranberry bog farm in Massachusetts. Ocean Spray came under pressure to respond to the growth of the convenient health category as cranberry drinks contained a lot of added sugar. They've found ways to produce a healthier juice, replacing sugar with natural sweeteners like stevia. Another product was launched called 'PACT' – promoting the proanthocyanidin content of cranberries, a powerful antioxidant.

Recent celebrity-endorsed campaigns such as that of Jamie Oliver's victorious sugar tax petition have further put the spotlight onto the importance of shifting away from sugary carbonated drinks towards healthier alternatives. Movements such as this one will continue to raise the profile of being health-conscious amongst multiple demographics.

In March 2011 the coalition government's department of health launched the public health responsibility deal. The initiative sought to bring together key stakeholders in the food and drink industry to request voluntary pledges, taking action to improve the health of the general public. The scheme had its critics and has been accused of failing to deliver. One could argue that, as it was voluntary, it would never achieve the results compared to mandated legislation. However it did demonstrate an effort on the Government's behalf to improve public health, if nothing else.

It is generally considered that beverages will dominate the future for healthy nutrition and functional foods. People prefer beverages as they are convenient, consistent in flavour, they can buy into a brand ethos, they are single-serve and they taste good (*IMI:2008*).

Recently sugar has become the food ingredient criminal of the moment, taking on where fat left off. Primarily this backlash against sugar relates to 'added sugar' as this is determined to be one of the contributing factors towards our ever increasing obesity and our ever-deteriorating public health.

The majority of fruit juices do not contain added-sugar, but are naturally sweet by their very nature. Year on year sales for fruit juices dropped 4.9% from 2014 to 2015 and this is blamed on the sugar debacle (*BSDA: 2016*)



As sea buckthorn is a tart berry, I am only too aware of the potential pitfalls. The easy option to widen the appeal of the products is to sweeten them. However, in doing so you immediately negate any health benefit you are trying to promote. Natural sweeteners such as stevia are just one option. This is the direction the soft-drinks industry is going with the likes of Coca Cola Life etc. Since 2012 there has been a 16% reduction in sugar intake from overall soft drink consumption (*BDSA: 2016*).

A tasty product is essential; time spent deliberating, experimenting and trialling in the product developmental stage will pay rewards in the longer term. This has to be the most appropriate strategy for sea buckthorn products.

6.4: Communicating the brand

There is an age-old argument as to which is more important, the brand or the product. In the past good branding could sell an average product, but only if considerable sums of money were spent on advertising and promotion. But are those sales sustainable in the longer term without the ongoing investment? It used to be the case that manufacturers would make a product and then tell consumers to buy it. This no longer works. The modern consumer is far more astute.

Success will only be realised by combining a good product, good branding and communicating a clear message to the potential customer. If a person subscribes to the brand's story, values and culture then they actually become ambassadors themselves, conveying your business message out amongst their family and social groups etc.

At the Contemporary Scholars Conference, we learnt from French communication expert Jean-Pierre Beaudoin that our societies consume fear more than hope. The first message they hear will be the truth (even if it's not); the second message will simply be a reaction to the truth. Public opinion is an available space that's up for grabs. Brands need to compete to fill that space and deliver the right message. Good communication is an integral part of brand success.

As there are currently only a small number of people involved with sea buckthorn in the UK, perhaps a collaborative approach would be the appropriate strategy. By pooling resources we could deliver one brand, one message and reduce the potential for confusing contradictions. It worked for cranberries with Ocean Spray, albeit it was not without its challenges along the way.

The one thing that the sea buckthorn market currently lacks is financial backing. When you look at Ocean Spray, POM Wonderful, both are potential contemporaries of sea buckthorn. Both are currently much more successful, in part due to significant investment in marketing and promotion.

Getting a familiar face to endorse a brand isn't always a credible method of communicating a brand; many sceptical consumers will assume (rightly or wrongly) that he or she has simply been paid to do so. However, when it comes to food, celebrity chefs are generally well liked and respected by the public. In recent years the popularity of chefs has continued to grow. Chefs have ventured beyond cookbooks and now have campaigns such as Jamie Oliver's Food Revolution and Hugh Fearnley-Whittingstall's war on waste. There are opportunities for brands to work with chefs and achieve a mutually beneficial outcome.



Social media is another huge resource for brands to communicate with. Content marketing with platforms such as Facebook, Instagram, Twitter etc. can gather vast exposure. It also enables a more personable and down to earth method of engaging with the public. Although mentioned in passing here (it really is an endless topic), it's an important and relatively simple component for brands to use as part of their overall communication plan.

Case Study Three: Greg Quinn – overturning a law to build a brand

With a widespread familiarity in this country, it's hard to fathom that once blackcurrants were as rare a crop in the USA as sea buckthorn is in the UK now. A similar comparison could be made that very few Americans knew what a black currant was then, just like very few Brits know what sea buckthorn is now. Currant production was outlawed in the USA in 1911 due to the fact the plant was an alternate host for white pine blister rust. This disease could decimate white pine trees and threatened the mighty logging industry in the north east. At that time logging was one of the most important industries the country had. The first American coinage featured a white pine on it, as did the first American flag.

Greg Quinn bought his farm in the beautiful Hudson Valley in 1999. A horticulturalist, Greg was looking for a unique crop that would be profitable off a small acreage. He discovered this legal obstacle after he had settled on blackcurrants as his crop of choice. Rather than being put off, as many of us would have been, he set out to overturn the law. The task occupied him for four years, but he eventually became successful in 2003.

Greg used this adversity to his advantage. His beautiful farmstead is surrounded by woodland and you wouldn't realise that it's just 90 minutes up the road from downtown Manhattan – an area of twenty million people. Word soon got out about an upstate New York farmer trying to overturn a law and the public and press became curious. As we know, everyone loves an underdog and Greg's story captured the hearts and minds of many.

Transforming this impediment into an opportunity gave Greg a credible marketing story and one that everyone really wanted to hear. The story featured on the front page of the Wall Street Journal, in a two-page article in the New York Times and was written about in The Washington Post, The Boston Globe and numerous others. It catapulted his brand and story into the lives of many and gave him exposure that money simply couldn't buy.

On next page see a photo of the law that launched Greg's blackcurrant business.



Figure 21: Proudly mounted on the office wall, the law that launched Greg's blackcurrant business.
New York State, 2016

6.5: A novel taste sensation

Throughout this report I have referred to the numerous health benefits of sea buckthorn. Indeed the majority of existing sea buckthorn products available on the market are aligned to take advantage of precisely those attributes.

Purely from a commercial business perspective, specialising solely on healthy products is rather narrow-minded and forfeits revenue generation from numerous other potentially lucrative markets.

It is safe to assume that sensory appeal – the appearance, colour, aroma and taste of a food item is probably the most important determining factor for its success or failure.

Novelty is another factor that is also a significant element of success. Chefs and consumers are continually looking for something new or something with a point of difference. This factor doesn't work on its own and can be a short-lived bubble or fad, but it also represents a significant opportunity. Provided of course that it tastes good – taste is always key.

After receiving a spontaneous recommendation from a Twitter contact, I made an unplanned visit to Denmark and dined at Formel B, a Michelin star restaurant in Copenhagen. One of their most popular dishes on the dessert menu was the sea buckthorn surprise. The staff attributed the overwhelming success of the dessert to the natural bright orange colour of sea buckthorn and the wholly unique taste. This reinforces the point that people love to try something different. I was sworn to secrecy not to reveal the details of the pudding, but needless to say it did not disappoint!

A photo of it is shown on the next page.

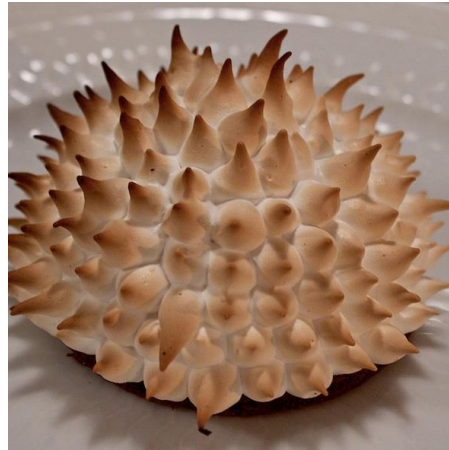


Figure 22: Sea buckthorn Surprise, Formel B, Copenhagen 2015

One of the first products I made with my own Cornish-produced sea buckthorn was a seaberry sorbet. Again this is not a particularly healthy product, in spite of the fact that it consists of only four ingredients. Nevertheless, feedback has been positive, with the majority of positive comments being made upon the refreshing tangy taste, the uniqueness of the flavour and the colour.

This demonstrates that offering a range of different products can not only spread the risk but also it can simultaneously broaden the appeal. Someone may initially try one format of product, enjoy it and then have confidence to try others in the range.

Near Potsdam in Germany, the Berger family have established a thriving, diversified business based upon their sizeable 150Ha of sea buckthorn production. In addition to having a modern processing facility, they have capitalised on their significant environmental capital - a thoroughly picturesque lakeside location - and have invested in a visitor/educational centre, farm-shop, gardens and a restaurant. They now offer tours, school visits, corporate events and weddings.

A festival weekend to celebrate the sea buckthorn harvest generates footfall well in excess of one thousand. The proximity to Berlin certainly helps this, but overall public recognition of sea buckthorn or 'sanddorn' is much higher in Germany.

A variety of sea buckthorn juice-based products form the business staples, but sales of more novelty type items are increasing rapidly. Sea buckthorn jams, liquor, chocolates, gummy bears and even candles all generate strong demand as does a premium range of skin care products. A total of seventy sea buckthorn product lines now exist and visitors from near and far can make repeat sales via the online shop.

See photos on next page.

In summary, although the health beneficial aspects of sea buckthorn are its most credible qualities, it would be naïve to rule out marketing other products to bolster sales and promotion of this fruit.



Figure 23: An array of sea buckthorn products



Figure 24: Sea buckthorn world



Chapter 7.0: Addendum: Britain and the European Union

In light of the recent referendum result concerning the UK's membership of the European Union, it would be prudent to comment on anticipated consequences of the outcome and impacts they may or may not have with regards to my study.

In one respect, a business should endeavour to be resilient enough to cope or adapt to any sudden change in circumstances in the business environment. Easily said, but not often easily done in practice. Particularly when the change is brought about by external influences that are out of the realms of control.

From my sea buckthorn perspective, prior to and over the duration of my Nuffield Farming Scholarship I have made multiple useful business connections, many of them in Europe. All plant stock is currently sourced from the EU. If the business grew to a scale where Cornish and/or domestic production could not satisfy the demand of the market, the opportunity exists to import produce from our production partners on the continent.

Volatile currency exchange rates will always be something that we will have to contend with. However, if we were outside the common market this could cause significant, costly and bureaucratic complications in such transactions.

Another consideration is that of labour. The majority of fruit production in the UK is labour intensive. The industry relies heavily on the free movement of labour, predominantly sourced from EU member states. Immigration was a contentious issue during the referendum. It is foreseeable that future access and immigration to the UK will become more restricted. This would be detrimental to the productivity, profitability and thus viability of the UK horticulture industry.

It is therefore imperative that the UK government puts an arrangement in place to facilitate the provision of labour to the industry. This could be similar to the now defunct Seasonal Agricultural Workers Scheme (SAWS). The matter is of utmost importance and is item five of The National Farmers Union Post EU referendum pledge; "Ensure British farmers and growers have sufficient supplies of labour" (NFU:2016).

The European Food Safety Authority (EFSA) currently manages all food and drink regulatory matters. One such matter pertains to product label health claims, ensuring consumers are not misinformed or led astray, and is mandated through precise regulation and monitoring. As sea buckthorn has excellent health-beneficial attributes, a label claim promoting or highlighting this to the consumer could be an excellent marketing tool.

It is widely expected that the UK government will adopt existing EU legislation for many matters and will continue to do so. However if the government decided to revert power back to our national Food Standards Agency then regulatory changes would be expected. This could provide both opportunities and challenges for British food and drink producers.



Chapter 8.0: Conclusions

- Firstly, if you have read my entire report, well done and thank you. In doing so you have inadvertently read the words 'sea buckthorn' 244 times. I can consider that my objective of raising awareness of this fruit is now accomplished with you
- Sea buckthorn is a functional food. It represents a unique healthy fruit proposition in a society that's becoming increasingly aware of the importance of a healthy diet and lifestyle
- A tasty product is essential. People simply will not buy a product that doesn't taste good, no matter how good it is for their health
- As with all crops, sea buckthorn has production challenges. The harvesting process still has significant potential for efficiency gains. Any improvements made will have a positive effect on gross margin outlook
- The lack of consumer awareness and absent existing market is a major obstacle to overcome in order for the UK sea buckthorn industry to flourish. However this also represents a vast opportunity
- Communication is integral. Consumers will support a brand which they believe has something to offer them that is unique and beneficial
- For growers who aren't too averse to risk, developing a sea buckthorn enterprise could offer an exciting new challenge



Chapter 9.0: Recommendations

- The Government needs to adopt a ‘prevention is better than cure’ attitude to public health. Instead of throwing good money after bad, propping up an overburdened National Health Service, investment should be made upfront in educating the population about ways to lead a healthy lifestyle and diet
- Sea buckthorn plant breeders need to continue to develop new cultivars and to breed for foreseeable future agronomic challenges such as pests and diseases. Fruit quality, yield, consistency and constitution will remain important characteristics. Breeding to facilitate a more efficient harvesting method may remove a significant obstacle to commercial uptake
- The benefits of sea buckthorn as a functional food need to be clearly conveyed to the consumer. Communication will be especially important as the general public will need to be educated about the advantages (and convinced of them) before they are willing to engage
- Stakeholders in the UK sea buckthorn industry need to come together and develop a strategy in order to deliver the same message to consumers. This will have the best outcome for the future expansion of the market



Chapter 10.0: After my study tour

Since completing my Nuffield Farming Scholarship study tour a lot has changed. Looking inwardly I think my own outlook and perspective has changed and I have become a more positive person.

I was recently elected to become the chairman of the United Kingdom Sea-Buckthorn Association (UKSA). It's not all prestige and glamour though. The reality is once or twice a year a few sea buckthorn enthusiasts meet in the back room of a pub somewhere and talk about how to propel the industry forward in the UK. Nevertheless, I believe that many great ideas and businesses originated in this fashion and I am very proud to be at the helm of the organisation. One of my principal short-term objectives is to increase the membership, so if you're genuinely interested, please get in touch.

Probably the largest consequence of my Nuffield Farming Scholarship was that it instilled me with the knowledge, mind-set and confidence to develop my small, hobby, sea buckthorn enterprise into a business. At the start of 2016 I took on my first Farm Business Tenancy from the Duchy of Cornwall.

After gaining a decent global insight into sea buckthorn I now feel that I can speak with authority on most aspects regarding this fruit. I am motivated to champion this fruit and to elevate its profile.

Engaging the public is something that the agricultural industry has historically been very poor at. With an increasingly urban population, there is a growing disconnect between society and farmers. People need to know where their food comes from and how it is produced. On the same note, people also need to realise the importance of having a healthy diet and lifestyle. I now consider it to be my responsibility as a Nuffield Farming Scholar to become an ambassador of change, to engage with the public and to promote agriculture as a whole.



Chapter 11.0: The real Scholarship experience

I have decided to include a small selection of anecdotes and observations from my travels in my report. Whilst being wholly off topic, they epitomise precisely what a Nuffield Farming Scholarship is all about. I think it would be an injustice not to mention these somewhere in my report.

You may ask any Nuffield Farming Scholar and they'll readily recall an amusing story or share an interesting impression encountered upon their travels. Needless to say when away 'Nuffielding' one can end up in all sorts of unplanned predicaments. This is precisely what makes it such special, character building experience.

Ordos, Inner Mongolia, August 2015

My fantastic Chinese hosts drove me out of Ordos's bustling city centre, through suburbs of endless blocks of eerily empty half-constructed skyscraper shells and down bumpy dirt roads through the industrial area.

This was opencast coal country and the roads were congested with trucks heavily laden with coal en route to the local power stations. As each truck passed, a sinister looking dark black cloud of sooty dust and spent diesel fumes followed.

On the roadside, a Chinese gentleman wearing a traditional conical sunhat was sweeping the road. As we drove past I remember craning my neck back and watching with fascination. As each truck passed by, a fresh layer of dust settled onto the ground. Continuously sweeping all the while, the man simply changed direction and returned back over the previously swept area.

I pondered over the futility of his endless chore. Did he recognise the pointlessness of his task? Perhaps he was just grateful to have a job, a wage and something to do. I can't help but wonder how he would answer if his wife asked him if he had had a good day at work.

The Middle of Nowhere, Romania, August 2015

I boarded a surprisingly busy 4am train in Budapest, bound for Romania. I had aspirations of staying awake to photograph the arrival of dawn from the train. Needless to say that didn't happen and after the border crossing procedures were complete I promptly fell asleep.

When I woke up the carriage was forebodingly quiet. Well to be more precise it was completely deserted. Not only that; but my empty carriage had been uncoupled from the rest of the train and was now abandoned in the middle of rural, unidentifiable Romania.

I clambered down from the train to survey the scene. My carriage was neatly parked on one of four railway tracks. The railway was perfectly straight and disappeared off over the horizon.



I decided the best plan was to continue on foot. After walking for around 30 minutes I came across a farmer tending to some sheep. The language barrier was painful and despite much gesturing, smiling and hand shaking we didn't achieve much. I gave him a freebie biro from a hotel and he gave me a cup of what I think was nettle tea.

I returned to the train, caught up on writing some notes and then caught up on some more sleep. I was jolted awake around midday when a train showed up and coupled onto my carriage. I was underway again, except this time it was back to Budapest.

The following day I repeated the procedure, except this time I ensured I was positively wired on coffee and seated in the carriage right next to the engine. When I eventually met my Romanian host he thought it was all highly entertaining and my train predicament kept him amused for much of the two days I spent with him.

Berlin, Germany, September 2015

Continental Europe was burning up in record-breaking sweltering summer temperatures. It was 5:30pm and for some very daft reason I found myself in amongst peak rush-hour pedestrian traffic jostling for position to board the S-Bahn in central Berlin.

After the boarding scrummage subsided, I was crammed in an unbearably hot carriage. Squashed would be an understatement; it made rush hour on the London Underground look like business class on an Airbus A380.

Whilst the train was underway there was just enough passing air movement to wick away the sweat from my forehead. Yet whilst momentarily paused at stations, I cringed with embarrassment and dismay as the sweat dripped from my forehead and down onto the handbag of the rather attractive lady I was squeezed next to.

The train drew to a halt just short of a station, presumably waiting for a signal. The heat was relentless and I was beginning to feel faint. All of a sudden there was a commotion. It became apparent that the gentleman dressed in an impeccable suit not far from me had unfortunately experienced what can only be described as an involuntary bowel evacuation.

The veritable stench was debilitating. As the stink rapidly diffused down the carriage I remember seeing a lady gag and then promptly projectile vomit onto her neighbouring commuters. We may only have been stationary for thirty seconds or so, but in that time absolute pandemonium had erupted in the carriage. The train lurched forward and as the doors opened the mass stampede-like exodus of the train was something I would never like to experience again!

New Delhi, November 2015

6:30am and New Delhi is waking up for another day. It's already quite warm and the air feels heavy. I'm waiting outside my guesthouse for my befriended tuk-tuk driver 'Amrit' to show up.



Across the road a greengrocer is setting up his roadside display. He casually throws some fruit into the road for a thin three-legged dog. The dog, clearly thinking its luck has changed, wags its tails and hobbles over to the shopkeeper. The man promptly hurls a bucket of putrid water over the dog and chases it down the street with a broom.

The chap returns and starts unwinding a tattered-looking canopy over the fruit below. As he does so, I see black dust, presumably sulphur particulates, raining down onto the produce. He disappears into the shop momentarily, returns with a grimy black rag and proceeds to give each individual fruit a wipe over.

I catch his eye and he beckons me across the road. He shakes my hand and asks where I am from. I answer and he then asks if I watch Coronation Street or support Manchester United. I meekly answer no to both questions, his face drops and I feel like I have failed as an Englishman. I rapidly redeem myself as we share a common interest in cricket. "Joe Root" he grins at me and pretends to bowl a mango down the street. Quickly switching back into a businessman he gestures to his stall and I end up buying a banana and a mango from him.

There's a commotion at the end of the street, lots of beeping and in a cloud of dust and two-stroke fumes Amrit arrives with a beaming toothy smile. "Good morning Mr Set" he beams at me, vigorously shaking my hand and then the greengrocer's - it turns out they are cousins.



Chapter 12.0: Executive Summary

When I applied for a Nuffield Farming Scholarship, I really did think my proposed topic was just a bit too unusual to be considered. As a fledgling sea buckthorn entrepreneur, I had already identified that a lack of knowledge and an absentee market were going to pose significant challenges for the future of the crop in the UK.

Public health in western societies is deteriorating. Much of this is attributable to poor diet. Opportunities exist for agriculture to deliver a revolution of healthy foodstuffs. Sea buckthorn is perhaps just one of many novel crops that could satisfy the increasing consumer appetite for health.

Sea buckthorn is a functional food, high in antioxidants and a credible source of essential fatty acids. It represents a unique value proposition to an expanding demographic of increasingly health conscious consumers.

It was clear that in order to promote sea buckthorn to potential UK consumers and growers, a more thorough and credible understanding of the crop was necessary. Established sea buckthorn growers are spread out across many countries and continents; I set out to try and visit as many as possible. From the technologically advanced to the subsistence, it was critical to gather a complete insight into the scope for this fruit as a crop enterprise.

Most crops have various agronomic challenges associated with pests and diseases and sea buckthorn is no different in that respect. The distinct production challenge that sea buckthorn has is the harvesting. There are numerous different approaches, but none of them are optimal. Inefficient harvesting accounts for over 50% of the production costs. An innovative combination of technology and breeding will have to be used to address this issue. If and when a breakthrough is discovered, significant efficiencies will be realised.

Production is only one half of the task though. The market in the UK is just beginning to develop. Elsewhere in the world sea buckthorn is big business. The fruit is part of the culture and consumers are well aware of its healthy characteristics. In the UK the consumer isn't particularly aware of either sea buckthorn or its potential benefits.

I visited both establishing and well-established businesses in comparable fruits such as cranberry, blueberry, blackcurrants, aronia and strawberries. It was important to draw comparisons, to learn the challenges and opportunities they had encountered involved with building their businesses and developing their marketing strategies.

The absence of a developed market is a challenge that is impeding the development of sea buckthorn in the UK. However it also represents a considerable opportunity. Sea buckthorn is well aligned for future consumer demands. There is no reason why it cannot become another fruit success story in the UK.

Seth Pascoe
July 2016



Chapter 13.0: Acknowledgements and Thanks

This small paragraph won't do it justice, but I would like to extend my sincerest gratitude to the Nuffield Farming Scholarships Trust and to my sponsor the NFU Mutual Charitable Trust. This life changing opportunity wouldn't have happened without their expertise and generosity.

My thanks also go to my parents who were head dog-sitters during my absence on overseas trips and provided me with many little words of wisdom along the way.

My girlfriend Laura hadn't appeared in my life when I was awarded my Scholarship back in November 2014. Little did she know that she would have to forego any chance of a holiday together and that all romantic mini-getaways would somehow nicely coincide with domestic Nuffield study visits. Her patience, encouragement and endless optimism have and always will spur me on.

A special mention of gratitude must go to Procam, who were very amicable and understanding to let me take such lengthy time away from work. Of course, trips weren't taken in the agronomy season.

It's beginning to sound a lot like an Oscar acceptance speech now, so finally a big thanks to everyone whom I met across the world. Without your invaluable knowledge, hospitality and generosity my study tour wouldn't have been even remotely possible.

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Epilogue:

Viktor Emil Frankl was an Austrian psychiatrist and holocaust survivor. After enduring three concentration camps Viktor wrote a book “Man’s Search for Meaning’. In this book Viktor reflected upon his experiences of life in the camps. He concluded that those who found meaning, even in the most atrocious conditions, were far more resilient than those who did not.

“It did not really matter what we expected from life, but rather what life expected from us. We needed to stop asking about the meaning of life, and instead to think of ourselves as those who were being questioned by life—daily and hourly. Our answer must consist, not in talk and meditation, but in right action and in right conduct. Life ultimately means taking the responsibility to find the right answer to its problems and to fulfil the tasks which it constantly sets for each individual.”

My interpretation of this quote is that Viktor was questioning the presumptuousness, nay arrogance of humanity with regards to the question ‘what is the meaning of life?’ As if it’s the responsibility of someone else to answer that question for us. Instead he is saying that the world is asking each of us that question, and our actions should be our response.

For me this very neatly encompasses the culture instilled in the Nuffield Farming Scholarship Trust.

As a Nuffield Farming Scholar one is encouraged to challenge the ‘normal’ way of doing something and to never become complacent and accept the ‘*but we’ve always done it that way*’ frame of mind. It’s a credit to the Nuffield Farming selection committee that each Scholar upholds this policy. Positive actions are implemented and shared across the world in whichever corner of agriculture he/she is involved with.



Appendix

List of countries where sea buckthorn can be found. I have indicated if the population is wild – native crop, or commercial – where orchards have been established. Where the country only has a wild population this does not necessarily mean there is no production, as the wild fruit may be harvested.

Country	Wild	Commercial	Country	Wild	Commercial
Afghanistan	√		Latvia	√	√
Bhutan	√		Lithuania	√	√
Belarus	√	√	Mongolia		
Canada	√	√	Nepal	√	√
China	√	√	Netherlands	√	
Denmark	√		Norway	√	
Estonia	√	√	Pakistan	√	
Finland	√	√	Poland	√	
France	√	√	Romania	√	√
Germany	√	√	Russia	√	√
Greece	√	√	Sweden	√	√
India	√	√	Tajikistan		√
Iran	√		Turkey	√	√
Ireland	√	√	Ukraine	√	√
Italy	√		U.K.	√	√
Japan	√	√	U.S.A	√	√
Kazakhstan	√				

***This table is not an exhaustive list, but is completed with my current knowledge at this time.



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