

FOREWORD

As the Senior Portfolio Leader for Development in Gwynedd Council, it is my pleasure to present to you the MENTERRA Product Packages.

Combining the Welsh word “menter”(enterprise) and the Latin “terra”(land), MENTERRA was the name given to this pioneering land-based initiative. In 2003, Gwynedd Council secured a £2.6m Objective One funding package through The Welsh Assembly Government, the WDA (which is now incorporated into the Assembly), University of Wales Bangor, and Gwynedd Council itself to launch this ambitious 3 year project (which was extended to a 4 year term). The objectives were:

- To establish the potential for agricultural innovation in Gwynedd
- Expand the economic basis of the industry
- Identify production opportunities and new processes
- Develop new agricultural enterprises
- Identify future target markets
- Establish procedures to undertake future crop research and create new enterprises

Since the project was established, it has given some 50 Gwynedd farmers an ideal opportunity to collaborate in the development of a range of crops that are different to those normally seen locally. Amongst these were **Crambe, Camelina & Linseed** oil crops, **Soft Fruit, Exotic Mushrooms**, and the first attempt in Britain to grow **Salicornia** away from its natural habitat. Advancing the development of this crop now forms part of a Trans European project, which will also research the environmental benefits. There was an attempt to improve upon the **Omega 3** fatty acid level in lambs, but without doubt, the outstanding success was seen with the **Naked Oats and Barley** growing trials and these crops have been the subject of very promising assessments over the last months of the project.

With the project now drawing to a close, it is time to reflect on what has been achieved from the investment, the innovative research and development work, and the commitment of the group of farmers and smallholders with an interest in diversification and trialling. Without doubt, one of the most important outputs of the project was the establishment of the **Agricultural Innovation Centre** at Henfaes near Abergwyngregyn, which was opened in 2004. This building, together with the expertise of the staff, will be a valuable long-term asset for the industry. The project also proved that a different range of crops could be successfully grown in Gwynedd and by now, armed with the knowledge gained from the research and the growing trials, it is encouraging to see two groups moving forward towards establishing co-operative businesses, in line with one of the project objectives, to further develop their produce and market it more effectively.

The Product Packages summarise all the findings and conclusions of the research trials, giving clear guidelines to those farmers who wish to further develop these crops. It is hoped that they will encourage those of you who have followed developments from the sidelines to consider taking advantage of new openings for producing different crops, to help secure prosperity within the agricultural industry in Gwynedd and to help sustain a strong economy and community in our rural areas.

If you would like more information, you can also visit our web site on www.menterra.org

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INTRODUCTION

This publication has been produced by MENTERRA - a Gwynedd multi partner agri-innovation initiative. Menterra has carried out extensive planning and research in order to establish which soft fruits were suitable for cultivating and commercialising in Gwynedd. A wide range of crops was evaluated in terms of soil compatibility, climate requirements and market potential. The most promising of those considered, including blueberry and chokeberry (aronia), were selected for growing trials and further market analysis.

The purpose of this document is to provide information to aid existing and potential producers or any interested party to exploit both local and national soft fruit markets. The document is based specifically on two crops – Blueberry and Chokeberry – and the information presented aims to point out key techniques in growing and processing these fruits, quality considerations, market development, potential competition and recommended routes to market for various fresh and processed product alternatives.

Blueberry and chokeberry were selected for inclusion in the Menterra programme because they represent a realistic diversification option and also offer local processing possibilities for existing and possible new ventures. Current estimates suggest that the fresh blueberry market in the UK is worth £10-£15M, with the bulk of the fruit being imported from overseas – showing clear opportunity to develop a local production base. Other berry fruits are also becoming more widely available and are experiencing a halo effect from the upsurge in blueberry sales, combined with increased research activity highlighting the health benefits attributable to berry fruits.

All the soft fruits grown under the Menterra project contain high anti-oxidant levels and could be used as health foods as well as more mainstream applications. Chokeberry is a good example of a fruit in the Blueberry family, which is currently very underutilised and offers significant potential.

Of the ten original trial sites, six are still operational - in Bala, Caernarfon (2), Pwllheli(2), and Trawsfynydd. The owners of these sites are actively pursuing a commercialisation strategy, having developed very promising product ideas. Further product development work is in progress as they form a co-op to exploit the full added value potential of the crops.

A darker influence on the future of Welsh farming could be the affects of global climate change. Already, these changes are being observed year on year and pose significant threat to the future of some traditional crops. There are likely to be winners and losers as farmers try to adapt to the new environment. Blueberry and chokeberry are crops that are known to be stable in the current and warmer climates. Perhaps surprisingly, soft fruit has been grown in North West Wales before, with commercial plantations of some significance on Anglesey supplying blackcurrants to *Ribena* until relatively recently.

With increasing consumer interest in health and well-being, many fruit growers could be unaware of the commercial value present in their gardens.

Origins and Uses of Blueberries

Blueberries' new reputation as one of the healthiest fruits in the world mean that they are now vying with strawberries and raspberries to become the premier fruit on supermarket shelves.

Blueberries are a group of flowering plants in the genus *Vaccinium*, sect. *Cyanococcus* and belong to the Rhododendron family (*Ericaceae*). The species are native to North America and eastern Asia. They are shrubs varying in size from 10 cm tall to 4 m tall, the smaller species are known as "lowbush blueberries", and the larger species as "highbush blueberries". The leaves can be deciduous or evergreen, ovate to lanceolate, and from 1-8 cm long and 0.5-3.5 cm broad. The flowers are bell-shaped, white, pale pink or red, sometimes tinged greenish. The fruit is botanically a false berry 5-16 mm diameter with a flared "crown" at the end; they are pale greenish at first, then reddish-purple, and finally turn blue or dark purple on ripening.

The blueberry season in Wales typically runs from late June to September, peaking in July. With flavours that range from mildly sweet to tart and tangy, blueberries are bursting with nutrition while being very low in calories. Cultivated highbush blueberries are deciduous, losing their leaves in winter, though some varieties such as 'Legacy' may remain evergreen in a mild winter.



*Figure 1:
Blueberries in fruit*

The blueberry, famous due to its use in traditional American muffins, is experiencing an explosion in demand with its increased use in pies, jams and also savoury sauces. This demand may well be driven by recent reports that it can reduce the risk of cancer and heart disease. Some retailers experienced a fourfold increase in sales during 2005 following publication of a number of articles extolling the virtuous health benefits of the blueberry.

The upsurge in demand has been met by imported fruit from sources around the world and provided that the fruit can be commercially grown could provide a huge opportunity for domestic growers to meet the ever-increasing demand for the blueberry as its repertoire of health benefits is explored and publicised.

Origins and Uses of Chokeberry (Aronia)

Aronia, sometimes called black chokeberry, is a deciduous shrub native to eastern North America. It is sometimes used in landscapes for its creamy white flowers in late spring, and colourful flame red autumn foliage contrasted with dark berries. Aronia is cold hardy and its late blooming period avoids damage by spring frosts. The plants tolerate various soils but prefer slightly acidic soils. Mature plants may be up to 8 feet tall and have up to 40 canes per bush. Numerous suckers are produced from the roots and fill in the space between the plants like a hedgerow. Thinning of older canes is recommended every few years to avoid dense growth and poor light exposure. Reduced light decreases productivity. The plants appear to be little affected by either pests or disease. Chokeberry clearly has potential for use as an alternative commercial fruit crop that may be suited to organic farming.

Little is known about the chokeberry from a commercial perspective, as it is heavily under-utilised. Chokeberries can be canned whole or the juice extracted for jelly making, yogurts, sorbet, flavoured milk and several other uses. In Russia, Denmark, and Eastern Europe the strongly coloured and pungently flavoured juice is widely used for juice and wine production.



*Figure 2:
Chokeberry in fruit*

The pea-sized, violet-black berries are harvested in autumn and have a strong, stable natural colour with a dry and sour flavour. Yields of up to 17 kilograms per bush have been reported from mature plantings in Europe. The fruit can be mechanically harvested with equipment similar to that available for blueberries but in smaller plants the fruit is hand harvested by cutting the fruit clusters. Harvest is usually in late August to September when the fruit is at 19° to 21° Brix (percent sugar).

Chokeberry has been increasingly used in the food industry to supply a natural red colour in products with poor colour stability. Commercially, chokeberry is mainly used for juice either alone or blended with other fruits such as apple or grape to achieve a blush. Other uses include food-colouring, tea, syrup and fruit spread colouring. In Russia, chokeberry and apple juices are combined and fermented to produce red wine, whilst in Lithuania, dessert wines are made using chokeberry juice alone or blended with other fruits. Reports from the Ukraine describe chokeberry as improving the colour, tannin level and sugar of grape wines.

Commercial juices are produced by pressing ripe berries then filtering and clarifying the juice. To reduce the tannins, a fining material such as gelatine is often added prior to filtration. The tannin will sometimes form complexes that cause cloudiness in clarified juices. Reducing tannin levels also yields a juice with a less astringent

flavour. Clarified juices may then be bottled and pasteurised or concentrated for use as food ingredients. Whole berries may be pulped to produce puree. This is a highly coloured product of smooth consistency with the seeds and skin removed. Hot break pulping improves product quality and stability. This product is frozen and used as a food ingredient in spreads and sauces. There are also reported uses of the dried powder of the berries as food ingredients.

GROWING GUIDE

Blueberries or chokeberries can be successfully grown in open garden, containers or raised beds where soil suitable for other ericaceous plants such as rhododendrons, can be provided.

Optimum soil acidity should be between pH 4.8 and 5.5, however they will tolerate soil around pH6 where plenty of organic matter such as fine pine chippings or peat has been incorporated. The crop will provide the best-flavoured fruit and the brightest autumn colour when positioned in full sun.

They are tolerant of wind, but in extremely exposed conditions some shelter is advantageous. Cold conditions down to -12C for short periods are acceptable for most varieties. The root systems of container grown plants, however, benefit from some form of protection in winter, such as fleece, straw or hessian sacking.

Much has been published in connection with the commercial cultivation of blueberries with little information available pertaining to the cultivation of chokeberry (aronia). The information below is focused on the blueberry but it is considered that much of the information is also quite applicable to the chokeberry. The information presented in relation to the harvesting is applicable, owing to both species having similar sized plants and berry forms – therefore mechanical harvesting techniques would be the same. Information below regarding the plant spacing and weed control is also applicable and should be adopted as best practice to minimise the influence of competitive growth from weeds, thus helping to optimise growing conditions and future fruit yields.

Soil type and climate

Blueberries are distinct among fruit crops in their soil and fertility requirements. Being native to North America, blueberries are well adapted to the warmer climates that are being experienced year on year as a result of climate change in Wales. Weather fluctuations and geographic seasonal advantage are the major economic considerations for variety selection. As members of the Rhododendron family, blueberries require an acidic (low pH) soil, preferably in the 4.8 to 5.5 pH range. When soil pH is appreciably higher than 5.5, iron chlorosis form; when soil pH drops below 4.8, the possibility of *manganese* toxicity arises. In either case, plants do not perform well.

Blueberries have a relatively low nitrogen requirement and thrive on organic fertilisers. Soil pH also plays a significant role in nitrogen management for blueberries. Research shows that blueberries prefer soil and fertiliser nitrogen in the ammonium form, absorbing and using it much more efficiently than nitrate nitrogen – the form preferred by most other commercial crop plants. Neutral and high-pH soils favour *nitrification* – the rapid conversion of ammonium nitrogen to nitrate through the activity of nitrifying microorganisms. In an acidic soil, however, the ammonium form of nitrogen predominates and is readily available to blueberries. For instance, when a slow-release organic fertiliser like fishmeal is applied, the nitrogen in the

proteins is converted first into ammonium. This ammonium – which would rapidly convert to nitrate under neutral soil conditions and be leached out of the root zone.

Perhaps the most common method of lowering soil pH in organic culture is by applying low levels of sulphur. Ideally, soil pH tests should be carried out in conjunction with sulphur applications before planting, to lower the pH to the optimal range of 4.8 - 5.5 pH for blueberries. Because soil pH is subject to considerable seasonal fluctuation – especially on cropped soils – it is advisable to do soil sampling and testing in winter or very early spring, when biological activity is low.

Seedbed Preparation and Planting

Blueberries do not have extensive root systems. As a result, clean cultivation of row middles to control weeds and to incorporate cover crops is less damaging to blueberries than it is to bramble fruits. Still, it is wise to till no deeper than 7-8cm. Similarly, inter-row living mulches – also called '*sodded middles*' – are generally not competitive with the crop unless the inter-row species are aggressive and invade the rows. Fescue is often used for *sodded middles*, as are several other grass species.



Figure 3: bed preparation at Cefnrhengwrt, Llandwrog

In some systems that employ *sodded middles*, a weed-free strip 15 to 30cm wide is maintained between the edge of the mulch and the cover crop. The strip reduces competition between the cover crop and berry bushes, and lessens the chance that weeds or the cover crop itself will advance into the mulch. It has the added advantage of discouraging cutworms, an occasional pest in blueberries. In organic systems, this strip is maintained without the use of herbicides.

Plant Nutrition

Soil-building practices prior to establishment can go a long way toward providing the fertility necessary for healthy blueberry planting. High levels of soil organic matter are especially important in blueberry culture, contributing to the soil's ability to retain and supply moisture to the crop, buffering pH, and releasing nutrients through decay. Soils rich in organic matter are also a desirable environment for *symbiotic mycorrhizal fungi* that assist blueberry roots in absorbing water, nitrogen, phosphorus, and other minerals. Green manures in advance of planting can play an important part in cycling organic matter into the soil system, as can applications of composts and livestock manures.

Once a blueberry planting is established, supplemental fertilisation can be applied in a number of forms and by several means. Generally, supplemental nitrogen is the greatest concern, followed by potassium. Blueberries have a low phosphorus requirement and typically require little, if any, phosphorus fertilisation. In fact, excessive phosphorus has been one of the factors linked to iron chlorosis in blueberries. High calcium levels are also undesirable.

Nitrogen fertiliser recommendations vary somewhat from region to region. As a general guideline, 45-55kg of nitrogen per acre is commonly recommended on mulched berries; a reduced rate of 20-30kg per acre is advised where little or no mulch is used. In conventional production, nitrogen is often applied in three split applications – one at fruiting, followed by two more at six-week intervals. Adjustments may be necessary for less-soluble organic fertilisers. One rule of thumb suggests that these fertilisers be applied from one to four weeks ahead of the recommended schedule for soluble fertilisers. This allows additional time for the decomposition processes to make nutrients available. Applications after mid-July are discouraged, as they tend to promote late growth that is particularly sensitive to freeze damage.

Despite the slower release of organic-based nitrogen, it is considered that nitrogen release from organic fertilisers will carry-over from previous seasons, possibly even releasing as much nitrogen as is being applied. It is possible to monitor this tendency by sampling leaves from the mid-shoot area on fruiting canes and sending them to an analytical laboratory. Lab results showing nitrogen levels below 1.6% indicate a nitrogen deficiency; a level above of 2.2% indicates excess nitrogen.

Potassium for blueberries is often adequately provided through decaying mulches. The need for further supplementation should be determined by soil and/or tissue testing. Where additional potassium is needed, it can be applied in a number of mineral forms – including sulphate-of-potash-magnesia or granite meal, and greensand.

High-quality compost is an all-around good blueberry fertiliser. Depending on the humus condition and biological activity in the soil, compost may provide all the fertility needs of the crop. Where compost is of average quality, it may still function as a good soil conditioner. Using aged animal manures in blueberry production also is possible, but less common.

Fertigation – the practice of injecting soluble fertilizers through drip irrigation lines – is a common practice in conventional blueberry production. Since fertigation is based on the complete solubility of fertilisers in water, there are limited options for organic growers. Early attempts at fertigation with blood meal resulted in clogged emitters and algae growth. The use of spray-dried fish protein and poultry protein in drip systems has been successfully demonstrated. In addition, several organic liquid fertilisers are available which are derived from fish emulsion, seeds, kelp, or seaweed.

Unlike the roots of grapes and bramble fruits, which grow well into the inter-row area, blueberry roots are not very extensive. As a result, all fertilisers and acid-forming amendments must be applied under the plant canopy to assure that they reach the roots.

Foliar feeding of blueberries is practiced by some organic growers and is especially helpful when plants are stressed. Foliar fertilisation programs usually employ seaweed and fish emulsion mix applied three times per growing season – at fruiting, just prior to harvest, and just after harvest.

Plant Spacing

Highbush blueberries are typically spaced 1.2-1.3m in the row, with 2.5-3.7m between rows. As bushes can get quite large at maturity, many growers find that 3-3.7m row spacing – approximately 900 to 1090 plants per acre – are preferable for tractor operations (mowing, harvesting, and spraying).

Some growers have experimented with denser within-row plant spacing for highbush blueberries, effectively doubling the number of plants per acre. Yields during the first five years after planting were found to be substantially higher (a boon to the overall economics of blueberry production – especially where growers have made high investments in drip irrigation and bird netting). These growers have been careful to point out, however, that beyond the fifth year, inter-plant competition may create problems, requiring removal of every other plant in the row. Fortunately however, highbush blueberries transplant easily, and removed bushes can be used to establish a new field.



Figure 4: plant spacing at Tyn y Bryn, Trawsfynydd

In-row Weed Management and Mulching

Weeds are considered by many growers to be the number one problem in organic blueberry culture, it is especially important to control aggressive perennial weeds prior to crop establishment.

Timely mowing – usually three to five times per year – is the common means of controlling weeds. It is most important that weeds not be allowed to produce seed that may be scattered into the rows and germinate later.

In many areas, blueberries are grown on mulched, raised beds but old highbush plantations are commonly grown without mulch because the mature bushes are less vulnerable to weed competition. Raised beds reduce the incidence of soil- and water-borne diseases. Thick organic mulches provide weed and disease suppression, soil temperature regulation, slow-release nutrients, organic matter, and moisture conservation. The latter is especially important because blueberry roots lack root hairs—the primary sites for water and mineral absorption on most plants. This characteristic makes water management of paramount concern and goes a long way toward explaining why irrigation and mulching are recommended practices.

Current recommendations suggest mulching a 90-120cm wide strip under the plants with 7-13cm of sawdust, bark, wood chips, or wood shavings. Organic growers often prefer a deeper mulch of up to 15cm over a strip at least 120cm wide. Ideally, the mulch should be sufficiently coarse to minimize crusting, and the surface relatively flat to encourage water penetration and gas exchange.

While the mulch suppresses many weeds, the moist organic medium can also become a haven for annual weeds (annual ryegrass and meadowgrass, stinging nettle) as well

as perennial weeds (dandelion, docks, sheep sorrel) that find a niche in perennial plantings. Strategic attention to weed control, even in mulched fields, is a major cultural consideration. If perennial weeds such as docks and creeping thistle are present these should be destroyed using glyphosate (e.g. Roundup) before cultivation. If possible this should be done well in advance (e.g. in summer before autumn planting) to allow several herbicide treatments. Control of perennial weeds is always easier to achieve and more effective before planting.

Tractor-drawn cultivation implements are impractical for in-row weed control on deep-mulched blueberries because blueberry roots often grow into the mulch, and significant plant damage can result from tillage. Shallow hoeing or hand-pulling weeds are two traditional options practiced by many organic growers.

A promising alternative to organic mulching is the use of fabric weed barriers. While fabric mulches may not provide all the benefits of deep organic mulch, they are highly effective for weed control and allow water to pass through. And, though the initial cost is high, it may prove reasonable when amortized over the fabric's expected lifetime of 10 to 12 years. All fabric mulches must be removed, however, before they deteriorate and decompose into the soil. Have a plan in place to deal with this eventuality.

Non-porous black plastic mulches – commonly used in vegetable production – are not recommended for blueberries. Polyethylene plastic mulch encourages surface rooting – making the plants more susceptible to drought stress and winter injury – and the plastic does not allow water to pass through.

Organic growers typically employ mechanical cultivators of various types to maintain the weed-free strip. Flame, steam, and infrared thermal weed-control systems are other options.

Pollination

Blueberries are insect-pollinated and thus, an increase in the number of pollinators can be quite beneficial. Blueberry flowers vary greatly in size and shape, depending on species. Therefore, having a variety of pollinators like horn-faced bees, mason bees, carpenter bees, bumblebees, orchard bees, and others is important for good fruit set.

Several varieties of blueberry require cross-pollination, and almost all varieties yield better as a result of it. In a pollination study, the variety Patriot, and possibly Northland, benefited from cross pollination, while the variety Bluecrop did not; therefore, highbush blueberry planting design must be based on the pollination requirements of the particular variety. Identify the pollinators that are most efficient for the variety and encourage them to remain in the area by creating insect habitats. Cover crops and adjacent vegetation may act as habitats for beneficial insects that provide pollination and help suppress pest insects and mites. When crops and field borders are managed with *beneficials* in mind, they often are referred to as *refugia*, and represent a new approach to attracting pollinators and natural enemies of pests, based on planned biodiversity.

Pests

Blueberries have fewer pest problems than most other fruits, offering an advantage for organic production. In some areas, most insect and disease problems can be controlled through cultural manipulation and proper cultivar selection.

Birds can wreck between 15 – 20% of the berries if no control measures are taken. Badgers, rabbits and deer are other threats and therefore, plantations should be fenced in and covered with netting, although fencing is expensive.

In order to minimise losses from birds, trial sites under the Menterra project adopted a netting system supported by a metal frame and pegs. It proved fit for purpose and could be re-used again the following season.



Figure 5: crop protection at Rhedynog, Chwilog

Harvesting

Harvesting can be performed manually on a small scale. It is, however very hard work and requires highly skilled fruit pickers to ensure that the crop quality is not compromised by poor handling. On a commercial scale mechanical fruit pickers are available in a variety of sizes from manufacturers, predominantly US and central Europe based. The closest harvesting machine in use in the UK would be a commercial raspberry harvester. To harvest on a small scale it may be possible to develop a machine with simple operation which obtains drive from the forward motion of a tow vehicle and collection of the fruit via small scale blower / vac units. This could possibly make mechanical harvesting cost effective for the Menterra growers or a group of growers in close proximity.

Mechanical harvesters rely on the planted rows being even and the plants being similar in height. They operate by driving along the rows and two vertical brushes “sweep” the berries off the plants. Similar devices are applicable for both blueberry and chokeberry plants due to the similar size of plant. Some form of blower system operates within the mechanical harvester to direct the fallen or picked berries into holding boxes.

Once the fruit is picked from the bush it is of paramount importance to process as quickly as possible to reduce the onset of spoilage via biochemical and enzymatic reactions within the berry. In areas where berries are established as a commercial crop, delivery to the processor takes place twice a day to ensure high quality is retained. The critical parameter is temperature. The berries must be harvested and the temperature reduced as quickly as possible this in turn will slow any reaction rate that may lead to a spoilage effect. This can be done at a small scale with refrigeration / cool air blowers in a holding room.

Shelf life

Fruits and vegetables in their natural state present a number of challenges in processed foods because of their high moisture content. Shelf life, functionality, and compatibility issues are common.

Different varieties of blueberries have different shelf lives. Modern varieties are longer lasting. The traditional ‘blue-crop’ variety can last up to 7-8 days in a cold store whereas modern varieties can last up to 12 weeks in cold store before being packed – after packing they still have a shelf life of up to 10 days.

COMMERCIAL OPPORTUNITIES

Why Commercialise Soft Fruits in Gwynedd?

With good preparation and management it is possible to achieve an adequate commercial growing environment for blueberry and chokeberry on Welsh soil.

Blueberries are already undergoing a market growth boom in the UK as the consumer becomes more aware of their health benefits. While almost all crops are currently imported this represents significant market potential for producers in Gwynedd. The chokeberry on the other hand represents even greater market potential as an alternative version of the *Vaccinium* species offering the same appeal to the modern health conscious consumer.

Health Claims of Berries

It is widely accepted that berries are known to have considerable health benefits.

High in antioxidants

Antioxidants form a class of ingredients that are becoming increasingly popular among consumers. They do not seem to be a passing fad, but are becoming a daily part of consumers' lives as we seek alternative methods to maintain our health. Berries, which are rich in antioxidants, can prevent chronic diseases such as cardiovascular disease and cancer.

Packed with antioxidant phytonutrients called *anthocyanidins*, blueberries neutralize free radical damage to the collagen matrix of cells and tissues that can lead to cataracts, glaucoma, varicose veins, peptic ulcers, heart disease and cancer.

Anthocyanins, the blue-red pigments found in blueberries, improve the integrity of support structures in the veins and entire vascular system. *Anthocyanins* have been shown to enhance the effects of vitamin C, improve capillary integrity, and stabilize the collagen matrix (the ground substance of all body tissues). They work their protective magic by preventing free-radical damage, inhibiting enzymes from cleaving the collagen matrix, and directly cross-linking with collagen fibres to form a more stable collagen matrix.

Eye health and good vision

Extracts of bilberry (a variety of blueberry) have been shown in numerous studies to improve night time visual acuity and promote quicker adjustment to darkness and faster restoration of visual acuity after exposure to glare. This research was conducted to evaluate claims of bilberry's beneficial effects on night vision made by British Air Force pilots during World War II who regularly consumed bilberry preserves before their night missions.

A better brain with blueberries

In animal studies, researchers have found that blueberries help protect the brain from oxidative stress and may reduce the effects of age-related conditions such as Alzheimer's

disease or dementia. Researchers found that diets rich in blueberries significantly improved both the learning capacity and motor skills of aging rats, making them mentally equivalent to much younger rats.

Market Drivers

According to the British Nutrition Foundation (1999), a functional food is defined as a food with health-promoting benefits and/or disease-preventing properties over and above its usual nutritional value.

Functional foods are continuing to gain popularity, mostly due to their convenience and appeal. They provide convenient ways to acquire nutritional benefits, while appeasing thirst or hunger and tend to fit well into an active lifestyle. As the market grows it is sourcing more and more fruit products with beneficial properties, particularly berries. Thanks to the health conscious consumer the market in fruit snacks is booming.

Consumer interest in the relationship between diet and health has increased substantially in Europe. There is much greater recognition today that people can help themselves and their families to reduce the risk of illness and disease and to maintain their state of health and well being through a healthy lifestyle, including the diet.

The Soft Fruit Market

The soft fruit market is rapidly expanding; multiple grocers are now offering more fruit varieties than ever before, including the more exotic varieties. Fresh fruit will continue to be one of the most buoyant sectors in the food market. The soft fruit market is worth £255 million, a 9% share of the UK fresh fruit market, valued at the end of 2006 prices.

Soft fruits are currently marketed as a luxury product at the top end of the market. The UK's best selling soft fruit is strawberries, but other fruits such as blueberries and raspberries are growing in popularity. Overall, the demand for berry products is growing strongly each year but some have a more significant place in the market. This is the case of blueberries.

Blueberries are no longer a niche crop. Over the last ten years they have become the third most popular soft fruit in the UK. Nevertheless, market indicators are up including frequency of purchase. Besides, there is little competition in the UK blueberry market.

The market size was valued at £10-£15 M as at February 2004 but is estimated to be worth £50M by 2010. On average, 1,500 tons are imported and 2,000 tons of blueberries are sold every year in UK supermarkets will significant growth predicted, possibly up to 50% a year.

Routes to Market: Food Products

As there are several commercialisation pathways available for the raw product and the most sensible distinction can be made by either food or non-use. The following diagrams illustrate key processes from both options and demonstrates all possible routes to market.

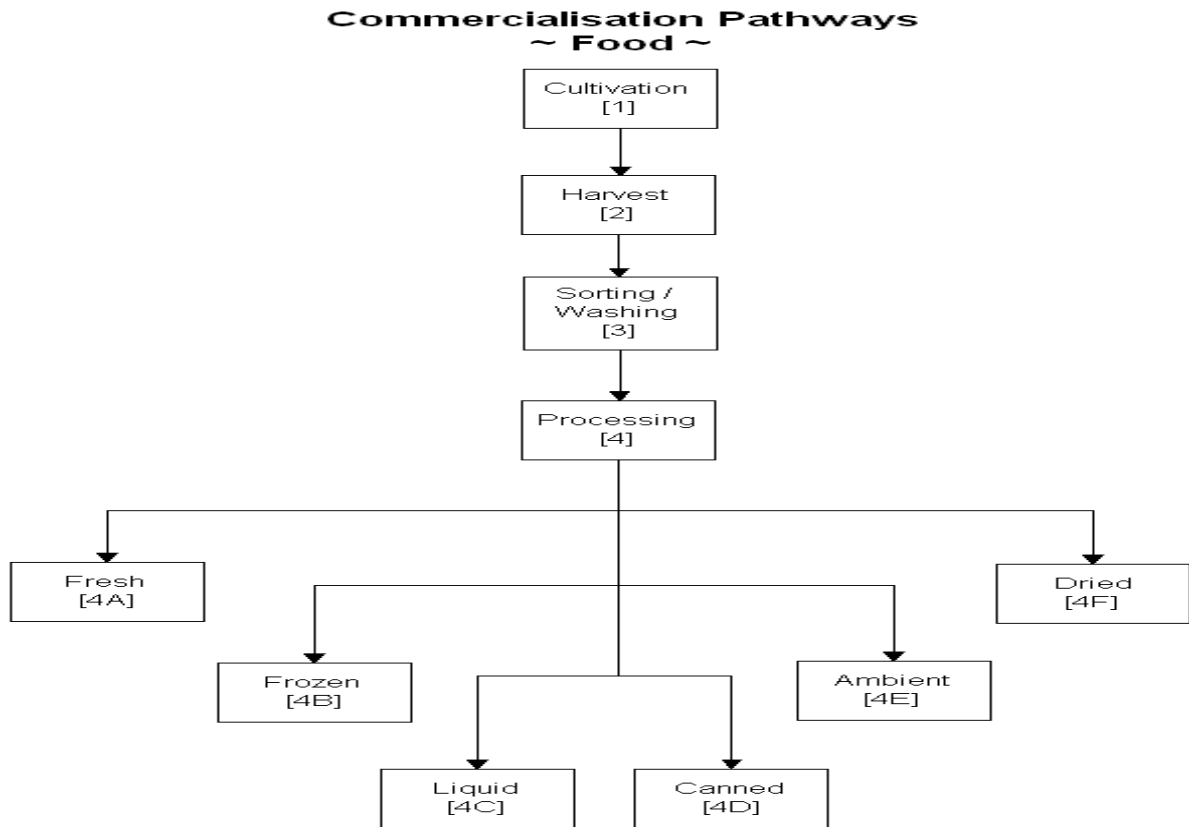


Figure 6: Various commercialisation pathways for soft-fruit food products.

Processing Flow (food)

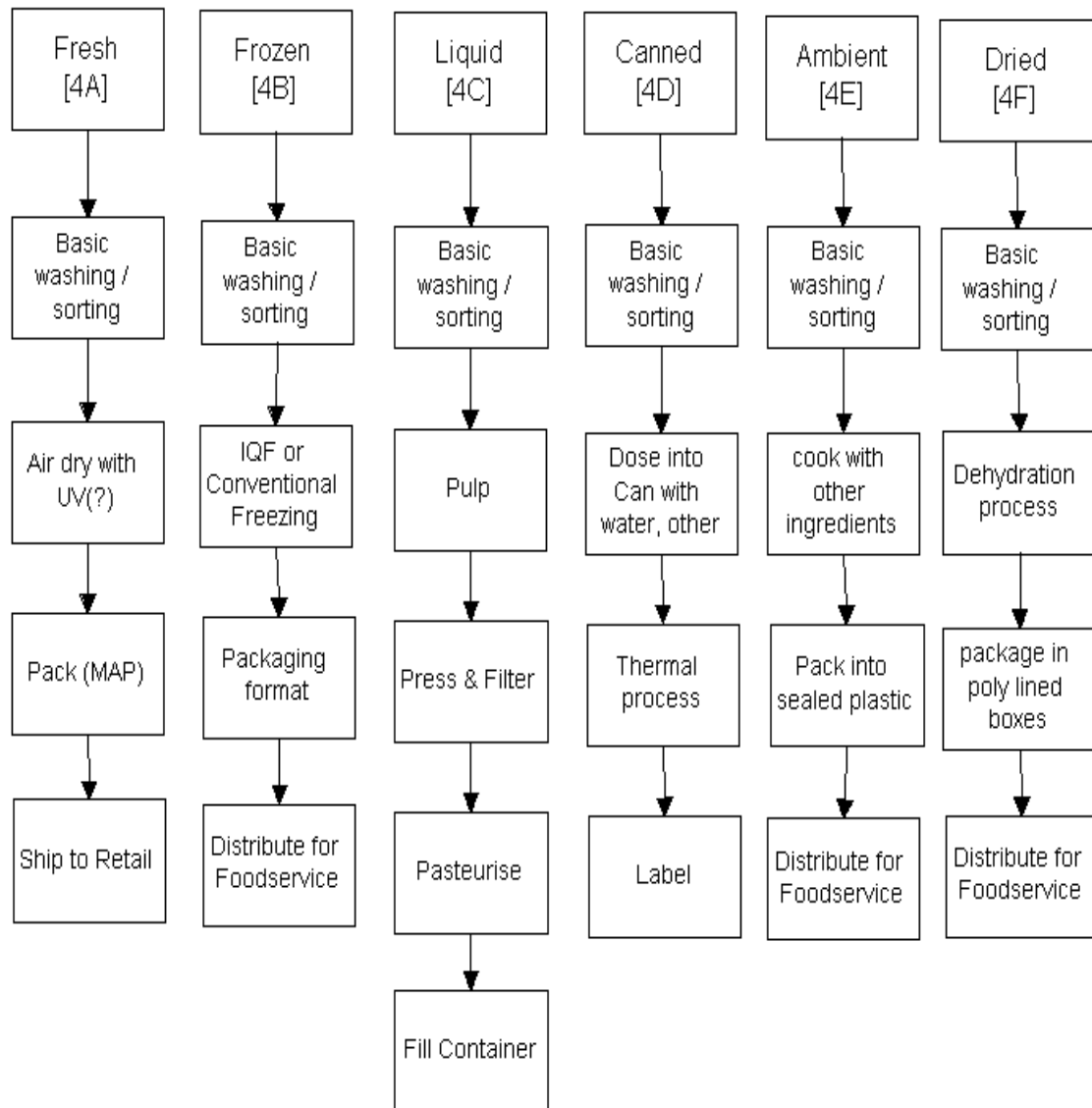


Figure 7: Processing flow diagram for food options.

Routes to market: Non-food Products

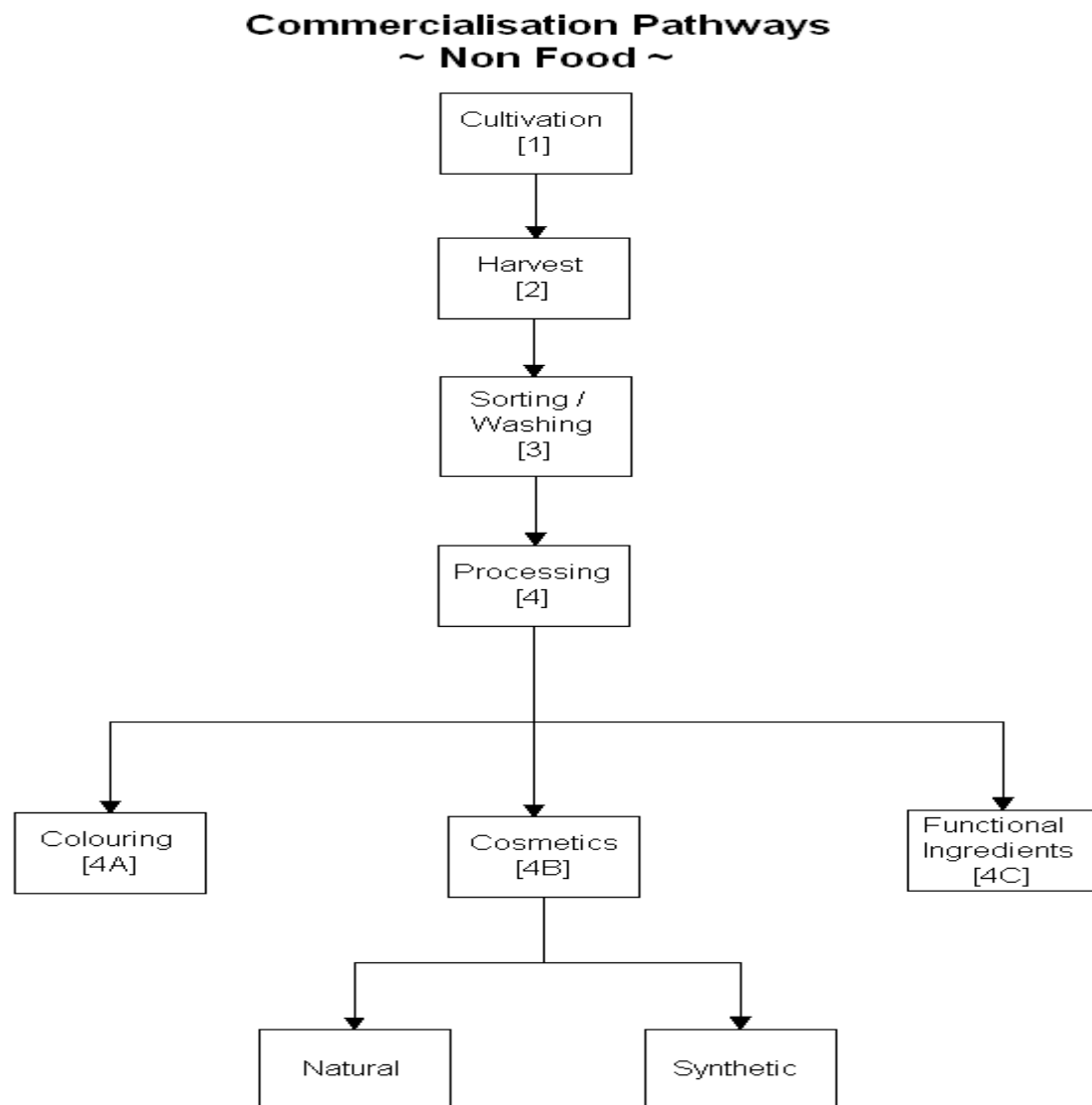


Figure 8: Various commercialisation pathways for soft-fruit non-food products

Processing Flow (non-food)

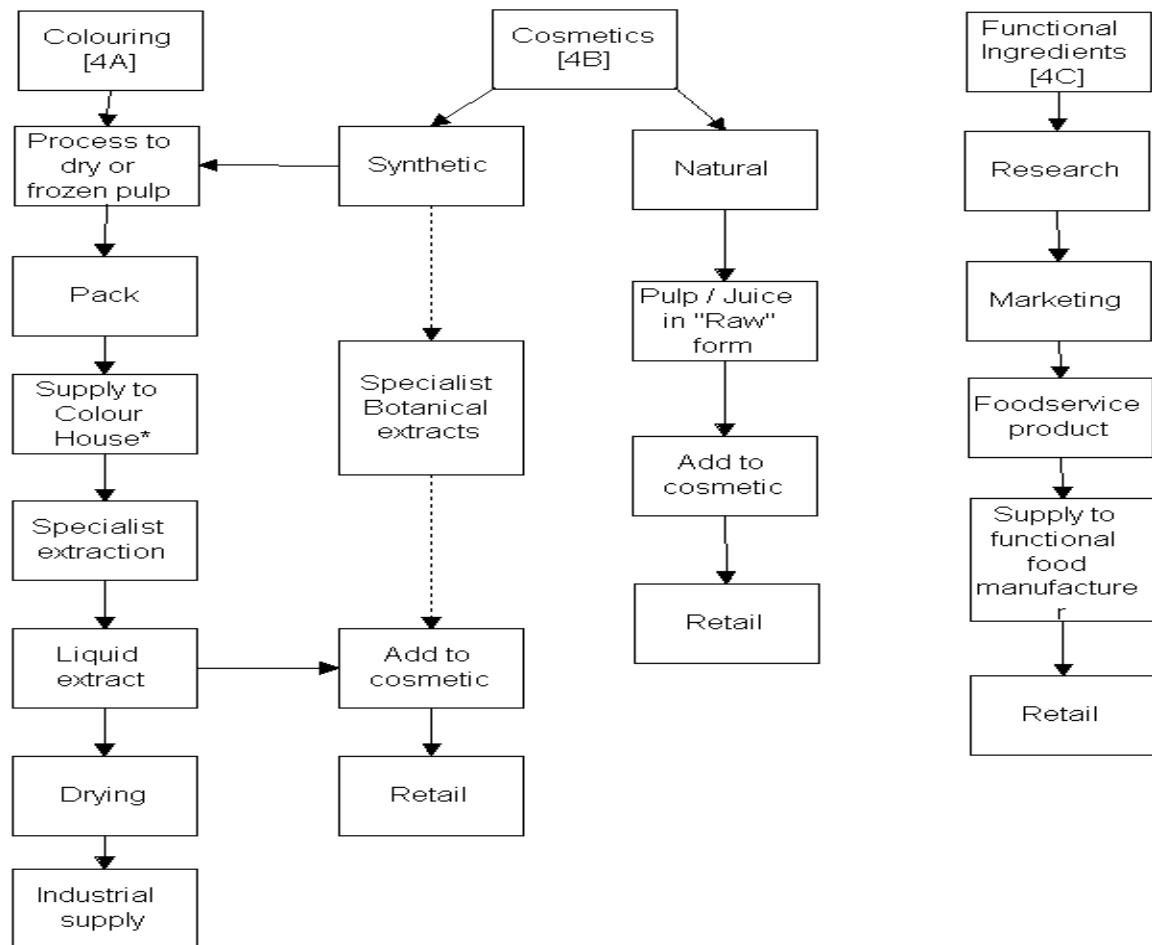


Figure 9: Processing flow diagram for non-food options.

Food Applications

Blueberries could be included in high value fresh products or sold as stand-alone fruit, but also as fresh berries or bespoke branded products. A potential margin of £2-£3 per plant can be achieved. Mark and Spencer for example sell Dorset blueberries for £2.49 per 250g although the Dorset Blueberry Company sell for £ 2.49 for 125g out of season.

As added ingredients in other products (especially for flavour)

There is an array of innovative products:

- Cereals, snack bars of all types (sports, energy, nutrition, breakfast/meal)
- Bakery (cookies, muffins, breads, biscuits, pies, pastry and other baked goods)
- Confectionary (chocolates, gum, pastilles, cough drops, other snack foods)
- Sauces and jams
- Dairy (yogurt, cheeses, ice cream)
- Beverages (juices, wine, ciders)

Juices

215 kilos of fruit are needed for a 75cl bottle of juice. (At the Dorset Blueberry Company, the berries used for the juice are imported frozen. For example wild blueberries are imported from the States)

As functional ingredients in the nutraceutical/pharmaceutical market

More and more, the use of botanicals in foods is becoming commonplace. Specialists companies now exist who take natural extracts from botanicals and produce capsule style supplement products. With the array of data supporting red berry fruits as a health food ingredient, it may be possible to market blueberry extracts in this area. However, products such as blueberry supplements are only available to the UK consumer in specialised outlets such as Holland & Barrett and the Internet.

Non-food Applications

If it were decided to produce juices as the primary product, the solid matter used for colouring could be sold on to specialists as an additional income. However, some functional benefit may be lost from the juice after the removal of the solid matter.

This is an area that increasingly calls on new botanicals and attempts to create a healthy and natural image. Some natural cosmetics already exist that contain blueberry extracts.

Product ideas

The most direct product form is fresh fruit, which the consumer can use as they please when preparing meals, or as a ready to eat part of their functional diet. Fresh supply options include the familiar 'sealed punnet' format, with which we would recommend adding a dark coloured tray to enhance the fruit colour and a fix-a-form label giving

branding and in depth fruit info. Ready to eat products include plastic tubs with built-in spoons. For longer shelf-life alternatives, the ring-pull can as a high quality niche equivalent to ranges offered by companies such as Del Monte. Frozen products offer consumers the advantage of being able to buy in greater bulk, whilst accepting a slight compromise in quality.

Soft fruits add flavour and higher nutritional values to existing categories such as desserts, snacks and milk substitutes. Organic fruits provide yet higher values and further boost to marketing the functional appeal. Products can be dairy or non-dairy, such as a soya milk drink with added fruit juice for functional health benefit. Desserts could include a berry fruit puree dessert and a non-dairy fruit-sorbet sold in a modern, stylish tub with foil lid.



Figure 10: Fresh fruit and functional dairy/non dairy product examples.

Breakfast is often remarked as being the most important meal of the day, but whilst being health conscious, today's consumer also wants convenience to keep pace with modern lifestyles. A good product opportunity is the "Instant Breakfast" - a microwaveable laminate pouch containing a ready made, quick cook, healthy breakfast. Just heat for one minute, open, pour into a bowl for a delicious and healthy breakfast – quick and no mess! For the consumer needing to eat breakfast on the go, a better alternative would be a fruit and cereal bar.

Fruit also offers higher values of luxury, premium and goodness to confectionery products. These products might include: 'Fruitarami' – the ambient fruit equivalent to the popular pepperami snack; farm produced real fruit Jellies, farm origin branded; and whole fruits coated in high cocoa chocolate. Also becoming increasingly popular are modern alternatives to jam, such as: sugar free jam - low calorie, tooth kind and diabetic kind, using Splenda sweetener; Fruit Butter, like peanut butter but fruity; and Fruit Spreads, like Nutella chocolate spread. Similar product ideas include fruit ketchup or fruit coulis - fruit sauce made with no preservatives to pour over desserts or even as barbecue dressings.

The juice/soft drink market always looks for interesting new combinations and provides the opportunity to supply real quality fruit juice in acceptable, familiar packaging. Options include: ready to drink varieties in single or bulk portion sizes; concentrated dilute to drink varieties; or mixers for cocktails. Indeed, another product opportunity is a range of alcoholic fruit drinks containing real fruit juice ingredients, not just flavourings.



Figure 11: Soft fruit drink and alcoholic fruit drink product examples.

Even at a relatively small scale of operation, there is a good opportunity to supply a number of complementary branded products to local shops and farmers markets, which demonstrate that farm produce adds value and raises local brand awareness. These include ice-lollies made from purees, fruit juices or smoothies and even fine teas using the fruit and leaves of the bush.

For consumers with a flair for cooking, a range of cook-in fruit sauces, fruit chutneys and marinades could be produced and designed/labelled to go with specific meats and fish. Recipes for meals made with soft fruits and meats could also be included with the fresh/frozen fruits to stimulate interest in the functional use of these ingredients. These might include: beef olives- stuffed with herbs and berries; rolled pork with apple and chokeberry; or sausages with meat, oatmeal and berries. This could even lead to opportunities to partner with specialist producers to create a range of functional ready-to-cook meals.



Figure 12: Low volume complementary example products.

With any new niche product offering, it is also worth considering new directions in packaging. Interesting examples might include self-heating/self-cooling cans, which contain a heating/cooling element activated by the packaging being opened. The 'Hot Can' could contain a ready to eat fruit dessert, while the 'Cool Can' could contain a refreshing still or fizzy fruit juice drink.

Packaging Systems

Packaging systems can be split between the following two categories, liquids and non-liquid. These two categories in turn can be further subdivided into food and non-food applications. Obviously for food applications there are several health concerns which need to be addressed and a multitude of companies are able to provide full “turn key” packaging systems for the commercial packaging of liquid and solid foods.

The pre-package processing will determine the package system required for any product and this area is one where only general information can be provided until such time as the product concept is known. Simple packaging systems are available for the packaging of fruits in their natural state. Following harvest and washing blueberries could easily be packaged using common form fill seal bag technologies. Some complexity is added if the fruit has been individually quick frozen (IQF) but the basic technology remains the same. The capital investment for these types of machine can be quite significant due to the through puts capable and in a start-up phase it would be sensible to identify contract packing partners for the packing operation which would be spread over a relatively short period possibly leaving any in-house packaging machinery dormant for long periods.

The size of the shipping boxes is important and will help reduce wastage in the event of any spoilage. If a large box is used and spoilage occurs then a large volume of berries are affected. If smaller boxes are used the effect is lessened.

By their very nature blueberries are a food source hence, non-food products will inevitably require partial or full processing before incorporation into the product. Blueberries are particularly high in anthocyanins, a substance used to provide colourings and dyes. This product would require an extraction process before any packaging operation and due to the specialist nature of the extraction any downstream packaging would be carried out on site following the extraction. Extractions yield a liquid concentrate, which can be packaged directly into suitable containers, or the concentrate can be processed further using a drying operation and the resulting powders packed into drums or bags.

Some information is included with this document to demonstrate the types of packaging technology available. Detailed information can be sought from the manufacturers who would be able to discuss the requirement with a more knowledgeable expert view.

Qualitative aspect

- Hand pack blueberries to ensure quality

The quality is important to the buyers. It is better to hand pack blueberries in order to make sure that no leaves or twigs get into the punnets.

Quantitative aspect

- How many fresh berries in a punnet?

If you would like to sell 250g of blueberries, you will have to actually pack 262g into each pack to allow for moisture loss.

How to pack blueberries

Blueberries growers, like the Dorset Blueberry Company sometimes have their own private packhouse. Their blueberries are packed in 150g and 250g punnets and heat sealed, labelled, dated and kept at 12°C.

It is also possible to contract a packhouse out. It should be noted that strawberries and raspberries are not packed the same way as blueberries. They are in bulk.

STRATEGY FOR COMMERCIALISING SOFT FRUITS IN GWYNEDD

Opportunities

The fruits selected for the Menterra project hold potential to exploit a number of market categories. The health food boom is one area that should receive careful consideration for marketing of a selected product concept.

For simplicity it may be sensible to start the crop commercialisation by selling fresh fruit or to select a product form that can be manufactured locally with the minimum level of capital expenditure. Following this initial approach, further options could be investigated with greater knowledge of yield expectation and seasonal influences.

Examples of product areas that may be of future interest could be:

- Niche Wines
- Mixer concentrates
- Liqueurs (products like Sloe Gin)
- Preserves

Some product development would be required to fine-tune the product offering but the above represent potential opportunities that could be exploited on a small scale producing high value products, which capitalise on the healthy content and imagery of the berries.

Process Flow and Risk Assessment

Before making the decision to grow blueberries, the following aspects have to be taken into consideration: -

- It can take 3 to 4 years to get any viable crops
- Hand picking the berries is very time consuming
- Three quarters of blueberries in the UK are being imported; the competition from abroad cannot therefore be underestimated
- The US and Canadian markets are extremely saturated, leading to growers there looking for new markets i.e. Europe
- An impressive array of blueberry products are available in the UK (nutraceutical market...) are bought cheaply from massive bulk producing growers abroad

Market Research

It is important to have sufficient market data to ensure that the product concept is a viable one (see Figure 11) and that there is a consumer demand before making the product choice. Having the relevant data will prevent needless sums of money being spent in a feasibility and development phase.

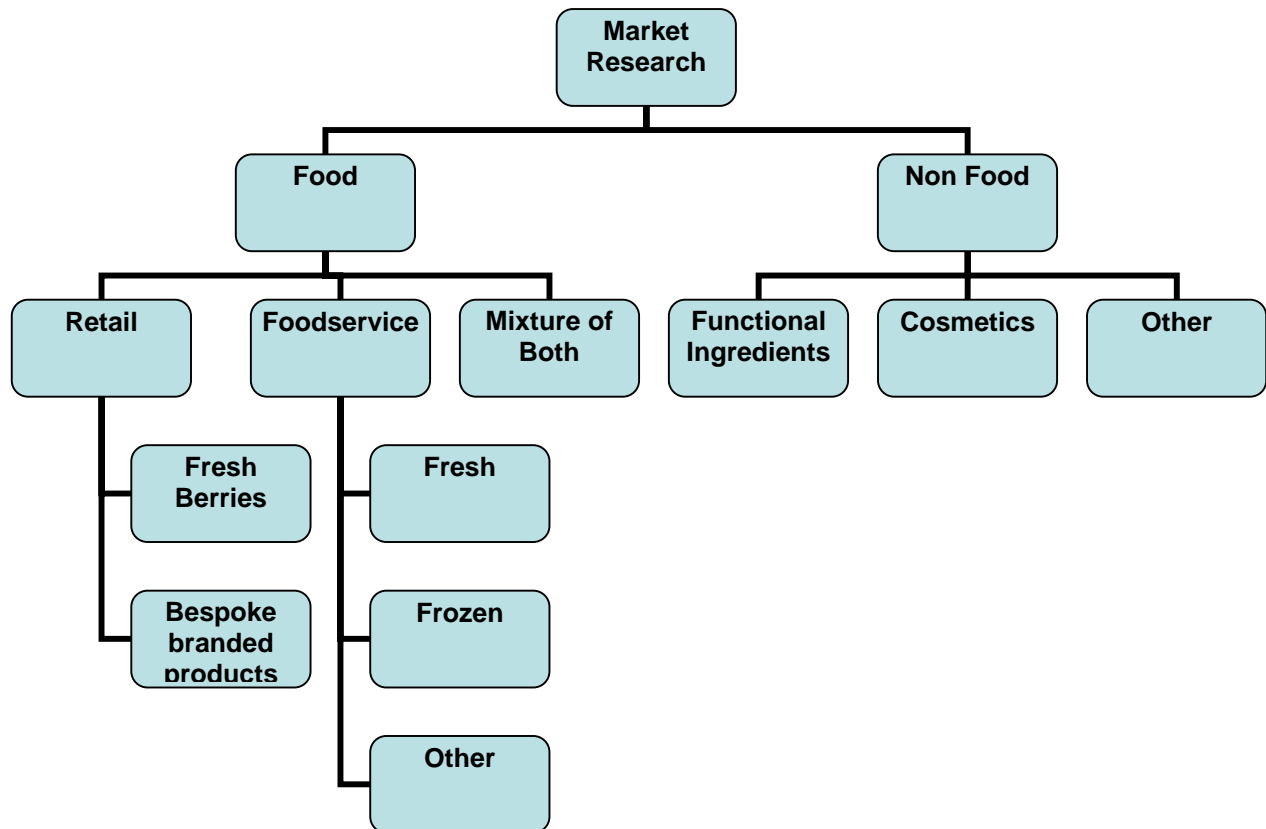


Figure 13: Market research areas of focus

Route to Market

- Define the product concept based on market research
 - ↳ Identify product to fit a market gap / consumer need
- Conduct feasibility
 - ↳ Provisional product costings and capital expenditure
- Develop product / process / package
 - ↳ Identify and develop processing requirements and packaging to create product offering.
- Develop or identify supply chain
 - ↳ Purchasing requirements, internal and external contracting for ingredients and services required
- Establish Bill of materials
 - ↳ Highlight cost of goods and services. Provides valuable information to establish selling price to achieve target margins

Factors Influencing Route to Market Choices

- Annual Fruit volumes harvested
 - ↳ Sufficient as individuals? Or better as Collective?
- Capital Investment
 - ↳ Where is the money coming from?
 - ↳ In-house manufacture or via third party?
- Distribution / Sales Channels
 - ↳ Growers Co-operative to pool resources

Launch Advertising - How to Make the New Product Successful

Concentrate on the functional food aspect

As interest in this category of foods has grown, new products have appeared and interest has turned to the development of standards and guidelines for the promotion of such products.

Take advantage of the consumers' new awareness for healthy food

Consumer interest in the relationship between diet and health has increased substantially in Europe. There is much greater recognition today that people can help themselves and their families to reduce the risk of illness and disease and to maintain their state of health and well being through a healthy lifestyle, including the diet.

The selection of ingredients is driven by three principal factors:

- a. Health and convenience trends,
- b. Technical aspects such as processing tolerance,
- c. Their ability to add value.

Ingredients, which fortify (herbals, vitamins & minerals) and ingredients which reduce (low-calorie sweeteners) are crucial to creating foods that are healthful and popular.

Distribution Channels

Whilst the ultimate aim would be to supply products direct to supermarkets, which are the clear leaders in grocery distribution, it is felt that for a niche crop like blueberry or chokeberry, the production volumes required:

- Small independent retailers or large chains
- Selling on the Internet
- Selling in farmers' markets

Key Players / Competition

The blueberry is indigenous to North America and as one would expect the majority of world production is derived from the USA and Canada where it has been cultivated since the early 1900's. From the early 1990's blueberry production has been reported in several countries however production remains highly concentrated in the USA

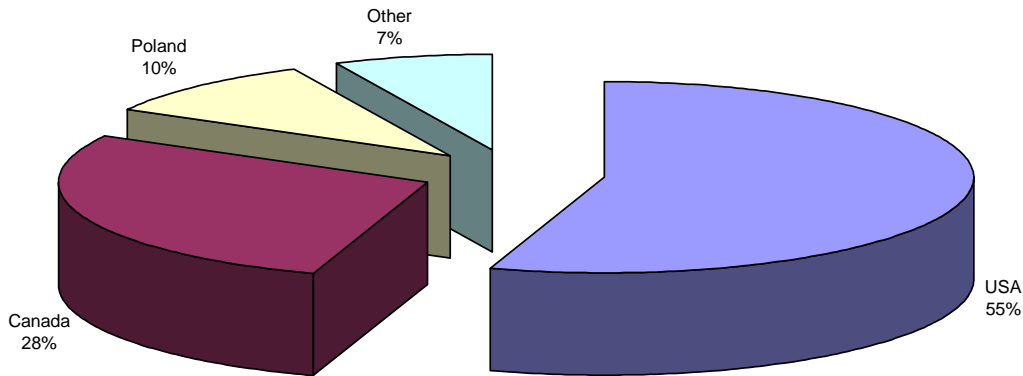


Figure 14: World blueberry production (2005)

Up to the 1970's Canada was the largest producer but since then the USA has gained ground and now benefit from per hectare yields double that achieved in Canada. Maine and Michigan are the areas that lead in the production of Blueberries, together accounting for half (37.5 Tonnes) of the USA production figure.

Within Europe production is on a smaller scale however, farmers are beginning to cooperate via self-implemented "cooperatives" to share information to maintain competitiveness within the European market.

Polish Farm Cooperative (in English)

<http://www.daar.pl/en.n.php/daargroup>

Polish Growers (in English)

<http://www.plantacjanadtanwia.pl/zarzad.en.html>

The Dorset Blueberry Company (UK)

<http://www.dorset-blueberry.com/>

Berry Scotland

http://www.berryscotland.com/berry_blueberry.htm

In the future the expectation is that the primary competition will remain the USA where production levels are high and infrastructure is available to cope with significant increases in production to meet non-domestic market needs. There is also a significant ability, from within central Europe, to grow and process fruit. Huge quantities of fruits such as strawberries, raspberries and cherries are grown in central Europe and Poland is already a large producer of blueberries. They have the ability to process post harvest using IQF technology in factories set up to process fruit brought

in from surrounding areas. With the entry of several central European countries in to the European Union and their low wage economies one could expect that producers in these areas will attempt to exploit the Western European markets further although there may be a lag until further planting matures sufficiently to meet the anticipated demand.

Little information was available relating to the chokeberry (aronia). There are no reported commercial growers in the UK and searches for products were confined to North America and mainland Europe but these products could not be considered mainstream and were concentrated in health food categories. With the lack of competition and the growing data promoting the health benefits of the aronia and other berries it may be an opportune time to develop and launch products, such as juice based drinks, that capitalise on the growing functional foods market and the consumers willingness to pay a premium for healthier options.

IMPORTANT NOTICE

This information is produced for guidance only. All crops are subject to seasonal variation and recommendations are based on knowledge currently available and results of field trials for the Menterra project. Any products mentioned are for illustration and are subject to change, other suitable products are available. The organisations participating in this project can bear no responsibility for damages or losses resulting from the use of the above information. If the grower has any remaining doubts about any aspects of the crop production, he/she should consult a professionally indemnified agronomist.

All agrochemical products must be handled and applied strictly in accordance with manufacturer's recommendations. Growers should consult the latest edition of the UK Pesticide Guide, or the Pesticides Safety Directorate at www.pesticides.gov.uk, for details of currently approved products specific to each crop.