

Nuffield Farming Scholarships Trust

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The Study:

Vegetable & Salad Production –
Seasonal Extension to Increase
UK Production

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writing. Where commercially sensitive issues are referred to in this report I may be bound by product or company confidentiality agreements.

1. Biography

I grew up on a smallholding near Ashford in Kent where my family produced a variety of crops and livestock. After completing a degree in plant biology at the University of Wales, Aberystwyth I spent two years travelling and working on a series of farms in Australia and New Zealand. I picked, packed, graded and weeded a range of fruit and vegetable crops which gave me an excellent appreciation of the realities of the fresh produce industry.

Upon returning to the UK in 2000 I began training as an agronomist working on lettuce, onion, carrot, leek, parsnip and potato crops in Cambridgeshire. I set up and managed an irrigation scheduling service and pest monitoring and forecasting system.

I moved to Cornwall in late 2001, having accepted a position as the technical manager and agronomist for Riviera Produce Ltd, one of the largest growers and packers of vegetables in the South West. The company specialises in brassicas but also has involvement with parsnips, carrots, potatoes, courgettes and soft fruit. Riviera Produce Ltd markets on behalf of 15 growers across West Cornwall accounting for around 40 per cent of the total Cornish crop, an area of approximately 4000 acres. During this time I worked closely with the University of Plymouth and the Horticultural Development Company to develop and validate a computer model used to forecast winter cauliflower maturity and completed an MPhil on the topic in 2006.

In 2005 I started my own consultancy business, Fresh Produce Solutions, providing vegetable growers in the south west with technical advice. I help growers and packers with varietal selection, agronomy and supply to the multiples, and hold an agency with the French company Clause to promote and distribute vegetable seeds.

I represent vegetable growers in the south west on the Horticultural Development Company field vegetable panel, at which decisions are made on the allocation of research money from the industry levy. I also represent growers in the south west on the technical committee of the Brassica Growers Association.

2. Background To The Study

The UK vegetable industry is far from self sufficient between the winter months of November and May, during which time a large percentage of the UK's fresh produce is imported from the continent and further afield. This is understandable, as outdoor production at this time is often unachievable. Worryingly, it is clear from DEFRA figures that the level of self-sufficiency in vegetable crops during the summer months is also suffering.

DEFRA statistics show that UK vegetable consumption went up by 3.4 per cent between the period 1996 to 2006, from 4.1 million tonnes to 4.3 million tonnes. Despite this modest increase, UK self sufficiency is falling rapidly. In 1996 approximately 80 per cent of vegetables consumed in the UK were home produced. However, by 2006 this had dropped to 51 per cent, a huge decrease (see figure 1).

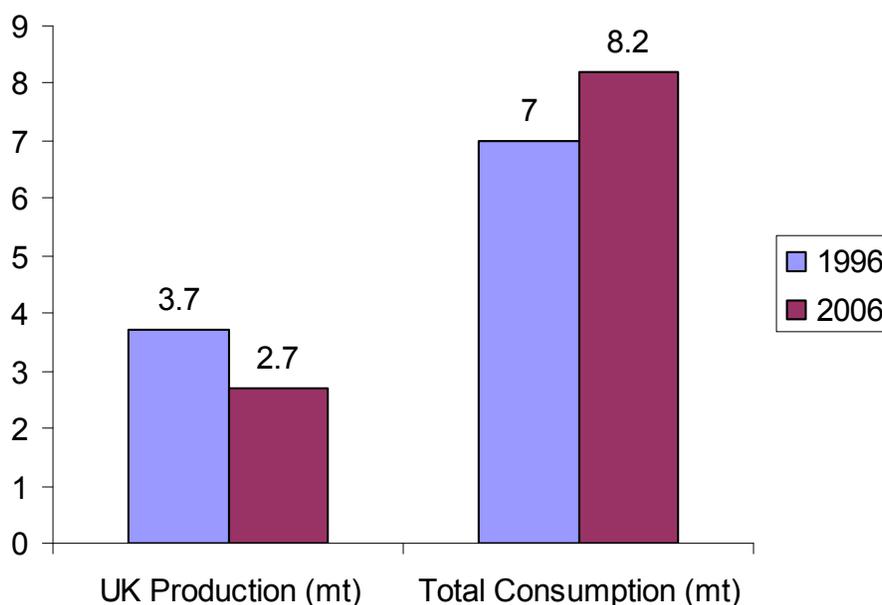


Figure 1 – UK vegetable production and consumption. DEFRA Stats 2006.

This decrease has occurred alongside the rise in dominance of the supermarkets, and is in my opinion related to the global buying power of

these organisations in which price becomes the most important factor and cheap imports the preferred option. Growers have seen diminishing returns coupled with often unrealistic quality demands and many have simply given up production in favour of other enterprises.

However, the 2008 increase in fuel costs vastly increased the price of imported vegetables. Despite easing of fuel costs in recent months the fragility of this dependency has been highlighted, and coupled with the weak pound means that UK growers are in a stronger position with increased opportunity to supply not only UK demand but also continental markets. There has also been strong political will to increase home production in the UK, and this looks to become a main topic of the forthcoming general election.

With these opportunities in mind it can only be hoped that the situation can be reversed as the area of vegetable crops grown in the UK begins to rise. It is becoming increasingly viable for growers to look at methods of production that can extend the current UK vegetable season in order to gain a toe-hold on early markets or to bridge the gap between winter and summer crops to ensure year-round production.

In Cornwall a climatic advantage is provided by our close proximity to the sea and the prevailing south-westerly wind. This allows the production of brassica vegetables through the winter months when other parts of the country are restricted by low temperatures. Cornish growers are able to achieve vegetable crops up to two weeks ahead of other UK growing areas in the spring, using techniques such as plastic bed covers and mulches to warm the plants and soil. There is also the opportunity to continue to produce crops into the autumn when other areas have finished, although this tends to be achieved mainly through cultivar selection than by other techniques.

For this study I visited a number of countries to try to understand how growers manage to produce vegetable crops to supply their domestic markets. As well as the opportunity to see different production methods I had a particular interest in both the techniques used to extend growing seasons and to identify how growers overcome the challenges surrounding the distance between crop production and the marketplace.

My scholarship took me to Canada, Brussels and China as part of the UK and Australian Nuffield Trust's global group tours, an excellent opportunity to set my topic in context with the global agricultural situation.

For my individual study I chose to travel firstly to Brittany in France, where the climate and cropping systems are similar to that in Cornwall.

In September 2007 I travelled to Bundaberg in Queensland, Australia to visit a number of fruit and vegetable growing and packing operations. Following this I visited the brassica growing region of Werribee in Victoria where the growers are facing many issues common to that in the UK. Finally for Australia I headed to Tasmania, again a region with a similar climate to Cornwall and with equivalent challenges in terms of distance to the markets.

Next I visited New Zealand and spent four weeks travelling from the far North down through the horticultural centre of Pukekohe, the dry East coast of Gisborne and the brassica growing areas around Wellington and Nelson on the northern tip of the South Island. I also spent some time with the large onion growers of the Canterbury plains around Christchurch.

Finally, in June 2008 I spent three weeks in the Salinas Valley, California, before a brief visit to Central America.

Inevitably, I found that the problems facing growers in the UK are mirrored by growers across the World, and much of my discussions became focused on the topic of diminishing returns and the vagaries of their supermarket customers. I found that, particularly with the brassica crops common to Cornwall, growers are becoming disillusioned and in every country the acreage of these crops are decreasing.

However, the professionalism and dedication of the growers and marketing organisations to meet these challenges is encouraging and I was given hope that despite their difficulties the companies I visited would be in a strong position for years to come.

3. The Australian Vegetable & Salad Industry

The gross value of Australian vegetable production stood at AUD\$1.8 billion in 2007 (Australian Bureau of Statistics). Interestingly, the value of horticultural imports reached AUD\$1.41 billion in 2007 compared to AUD\$867 million in 2002, a rise of more than 60 per cent across the period, with warnings being sounded by industry organisations about the loss of Australian self-sufficiency in both fruit and vegetable production.

I began my Australian travels in the Bundaberg district north of Brisbane, where sub tropical temperatures and close proximity to the sea provide an excellent climate for year-round production of fresh produce. Vegetable crops are mainly comprised of tomatoes, peppers and courgettes, with other hot-climate crops such as chillies and sweet potatoes also playing a major part. The total annual value of vegetable production in the Bundaberg district is approximately AUD\$209m (Bundaberg Growers Association).

Next I visited the Werribee region near Melbourne. The state of Victoria is the largest contributor to Australian vegetable production with a gross annual value of production of AUD\$487.2 million or 27 per cent. Victoria's most valuable vegetable exports are asparagus and broccoli with tomato exports showing the most dramatic increase compared with the previous year. This is mainly due to large investment in glasshouses for guaranteed production, a subject that I will touch on later.

Heading to Tasmania, I found that vegetables account for 20.9 per cent of Tasmania's total agricultural production, an annual total of AUD\$179.5 million, 8.5 per cent higher than in the previous year (Australian Bureau of Statistics). The majority of crops are grown on the fertile red soils in the North-west Forth region with approximately 75 per cent of the vegetables produced under contract for processing by Simplot or Heinz-Wattie. Production has also

expanded into the light soils of the northern Midlands in recent years. Brassicas, lettuce and carrot crops are grown for most of the year, although there is a distinct peak of activity during summer and autumn. Tasmania's mild climate allows the production of heat sensitive vegetables such as lettuce and celery to supply market gaps in mainland states during summer.

Figure 2 gives more detail on Tasmanian vegetable crop production.

Vegetable Production 2004: Gross Value (\$ million)

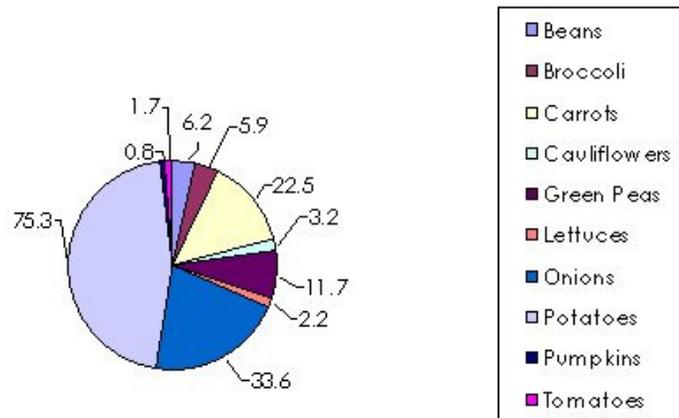


Figure 2. Tasmanian Vegetable Production 2004. (Australian Bureau of Statistics)

There are many similarities between Tasmania and Cornwall in terms of vegetable production. The fresh vegetable market in Tasmania is relatively small, because it has traditionally supplied a market of less than half a million people. While Tasmania has been a major supplier of fresh potatoes to Melbourne and Sydney markets in the past, the fresh vegetable industry has relied almost solely on the local market and has been fairly static, with some vegetable lines fluctuating little from year to year. The export onion industry is an important exception to this, as with winter cauliflower in Cornwall, where large volumes of the crop are grown and exported to other parts of the country or worldwide.

Recent investment in glasshouse facilities has resulted in production of fresh vegetables such as tomatoes becoming increasingly important for interstate and overseas markets. The major overseas destination is Asia, with Japan, Singapore, Hong Kong and Taiwan representing the major growth segments of the market.

The vegetable industry in Tasmania is very dependent on the Federal Government's Tasmanian Freight Equalisation Scheme (introduced in 1976) to offset Bass Strait shipping costs to interstate markets. This assistance ensures that Tasmanian growers and exporters are able to compete with their mainland counterparts, yet despite this Tasmanian vegetable growers are finding it harder to compete on the global vegetable market with cheap imported products from Asia depleting the processing market.

The vegetable industry in Australia contributes a research and development levy of 0.5 per cent of gross product value at the first point of sale, and this is

matched by the Government. Although this is not well received by everyone, most growers are contributing to discussions on priority areas for new projects and seek information about existing projects. Most vegetables are included in the levy except potatoes, processing tomatoes, onions, garlic, melons, asparagus and mushrooms, all of which have their own levy arrangements.

Water is an important issue for Australian grower, with water rights, cost and availability limiting growing areas and leading a number of growers to invest in glasshouse facilities to ensure targeted water use. In Werribee water quality is a huge problem to brassica growers, as with a falling water table salinity has increased.

Australian growers are facing a number of challenges common to the UK, not least being the difficulties of meeting supermarket demand. Food safety is very high on the agenda, with a UK-led focus on HACCP and a demand for certification to the BRC standard. At every packhouse and large grower I visited I found a thirst for information about these standards and which direction they might take next.

4. The New Zealand Vegetable & Salad Industry

New Zealand is blessed with a wide diversity of both climate and soils, allowing most vegetable crops to be grown in some part of the country through they year. The fresh vegetable industry in New Zealand is characterised by small owner-operated enterprises. There are approximately 1,285 vegetable growers in New Zealand who produce over 50 crops on an area of approximately 25,000 hectares with a farm gate value of NZ\$304 million per annum. Including such commodities as wine, the horticulture industry is worth NZ\$4.7 billion, making it New Zealand's sixth largest industry. Figure 3 shows the locations of the main growing areas in New Zealand.

Domestic consumption accounts for a high proportion of vegetable production, but annual vegetable exports are worth approximately NZ\$423 million, comprising of fresh vegetables, mainly onions and squash (NZ\$251 million) and processed vegetables, mainly frozen peas, corn, and mixed vegetables, tomato products, frozen potatoes and dried peas (NZ\$173 million). Due to the relatively low population and distance from market, over production of other vegetable crops is often an issue as there are limited opportunities for export of short-life fresh produce.

Vegetable production is a large seasonal employer. Around 23,000 people are employed in the New Zealand vegetable industry during peak times, and it is refreshing to visit a country where agriculture plays such an important role to the population.

The New Zealand government is very supportive of vegetable production in the country. The organisation Horticulture New Zealand represents 7,000 commercial fruit and vegetable growers to develop the industry's profile as well as advising growers on environmental issues, labour and employment and food regulations.

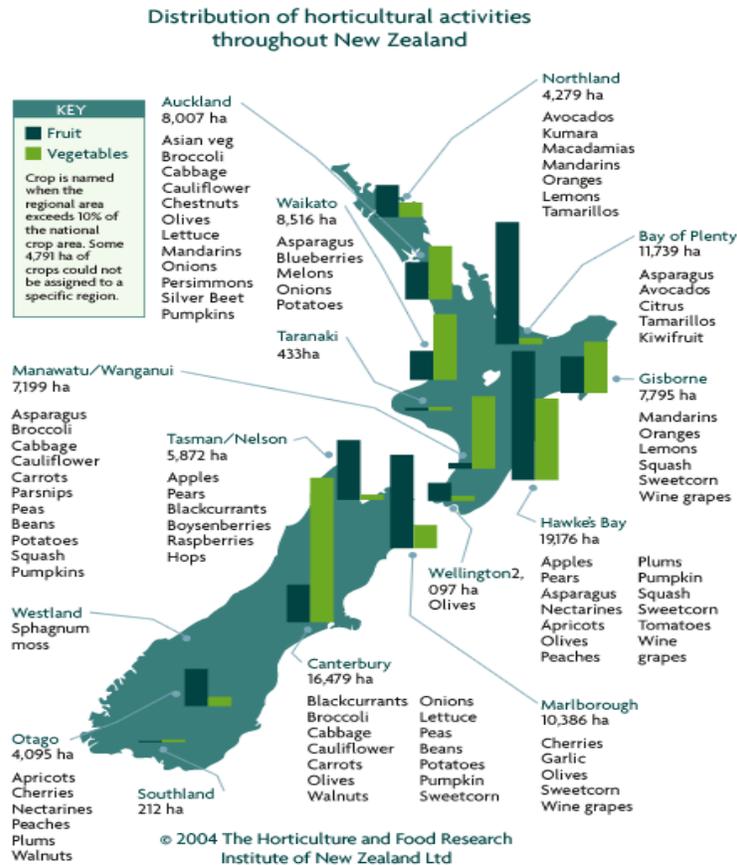


Figure 3. Location of main horticultural growing areas in New Zealand.

5. The Californian Vegetable & Salad Industry

No study tour looking at the vegetable industry would be complete without visiting the Salinas Valley. Located in the central coast region of California the valley is framed by mountain ranges on the east and west and runs 50 miles in length. It is the site of most of the agricultural activities in the county and is known as "the salad bowl of the world" because over 80 per cent of the lettuce grown in the United States is grown here. The soils are deep, rich, alluvial silts with an excellent underground water table.

The Salinas Valley has a ten-month growing season with a moderate climate regulated by the Pacific Ocean, to which the valley opens at the north end. This marine influence cools the valley and makes possible the wide range of crops found here. Typical daily highs range from around 15 degrees Celsius in

the winter to 30 degrees Celsius in the summer. The difference between ocean and air temperature also tends to create heavy morning fog during the summer. The average annual rainfall for the valley is only ten inches, but the easy availability of underground irrigation allows intensive crop production.

With a total value of over US\$1.9 billion, the Salinas Valley is the fourth highest agricultural producing county in California. The total land devoted to agriculture is approximately 1.4 million acres, and prime, irrigated land is around 220,000 acres. This is achieved by only 1209 farmers.

The Salinas Valley is notable for its broad diversity of crops, many of which are grown year-round. Approximately 50 commodities in the county have a gross value of more than US\$1 million each. The largest areas of vegetable crops include broccoli, cabbage, and lettuce. The table below shows both areas grown and total value of the most important crops to the valley.

CROP	ACREAGE	PROD/ACRE	TOTAL VALUE
Broccoli	51,000	7.6t	US\$260m
Cabbage	5,100	20t	US\$34.4m
Cauliflower	17,000	9.15t	US\$103m
Lettuce	153,000	N/A	US\$1,122m
Strawberries	9,630	35t	US\$605m
TOTAL VEG	321,000	N/A	US\$2,516m

Source: Monterey County Crop Report 2007

Further inland is the Central or San Joaquin, Valley. Here I visited T&A's Central Valley site at Five Points. The 15,000 acre farm grows brassica and other vegetable crops for short window of about 30 days when Salinas is too cold. The coldest month of January sees production move to Yuma in Arizona. Around 300 acres are under organic production but this is falling due to decreasing demand.

Outside of the 30 day shoulder season for vegetable crops the farm produces onions, peppers, watermelons and cantaloupe melons. However, water availability is becoming a huge issue. There is a massive aqueduct that runs 750 miles from the Sierra Nevada mountains to Los Angeles, but the water allocation for the season is only 25 per cent. Unlike Salinas it is not possible to use boreholes as the water is too saline, and due to the water allocation only 8000 of the available 15,000 acres will be farmed this year.

6. Methods of Seasonal Extension in Vegetable & Salad Crops

In many situations, with the right climate and soils growers can achieve crops year-round with season extension techniques. Cultural practices, plastic mulches, covers and tunnels can provide growers with earlier, later, and higher quality produce that can both capture markets and demand higher prices.

Traditional methods include cold frames and cloches to protect individual plants. Plasticulture (use of plastics in agriculture) has greatly extended the possibilities for year-round production on a large scale, helping growers to protect crops from cold weather. The use of plastic in horticultural crop production has increased dramatically in the past decade and most of the growers I visited used plastic at some point in their production cycle.

I will examine in detail the various methods through which the vegetable growers I have met during my Nuffield experience achieve extensions to the harvest period of their crops, together with potential for use in the UK.

6.1 Advantages and Disadvantages of Season Extension

Benefits from extended production include a more steady cash flow, an early hold on the market allowing faster scaling up of production into the main production season, and higher prices at times of the year when other local growers (who have only unprotected field crops) do not have produce. With extended production it is also possible to retain skilled labour that might otherwise be lost at the end of the outdoor growing season, or may allow a period of earlier training in preparation for the main season.

Disadvantages include no break in the yearly work schedule, increased management demands, higher production costs, and plastic disposal problems. I will deal with the balance between earlier production and the potential difficulties in my recommendations.

6.2 Geography & Site Selection

Most large packing companies achieve year-round supply by making use of the diversity of climate and geography available to them. In some cases, particularly in the UK, this may result in sourcing vegetables from overseas.

New Zealand has a relatively small population of four million, and is so remote that it is economically unviable to rely on fresh produce imports. To achieve a majority of home-grown produce the packing companies rotate their grower base starting from the sub-tropical area at the north end of North Island and moving south with the seasons to grow temperate crops in the central North Island near Pukekohe.

This is also a technique used by companies in the USA. Tanimura & Antle use the Salinas valley for ten months of the year and transfer lettuce production to Arizona and then to the Central Valley in the winter when it becomes too cold in Salinas.

Site selection is also very important for extended-season crop production. Frost pockets, higher altitudes away from the sea and North facing slopes need to be avoided when attempting to grow earlier crops. Soil selection can also have an effect as light, well drained soils tend to produce earlier crops in the UK as wetter soils tend to have a lower temperature.

Geography & Site Selection in the UK

Growers in the UK are already using geography and site selection to their advantage wherever possible. Early, late and year-round vegetable crops are traditionally grown predominantly in Cornwall but also Kent, Suffolk and the Isle of Wight, while through the main summer season the fertile silts of Lincolnshire provide the bulk of the vegetable production. This geographic strategy is now led by a limited number of packing companies.

Further challenges for Cornwall's growers come in the form of the recent cycle of mild winters which have reduced the climatic advantage and made it increasingly viable to grow winter brassicas in other regions of the UK. In recent years there has been a gradual increase in winter vegetable crop production in Lincolnshire, largely as a result of two extremely mild winter seasons. However, it may well be worth considering long term trends if planning such a shift. As I write the recent cold weather has begun to affect crops grown away from the traditional areas and it is possible that this strategy may falter in forth-coming seasons.

If these trends do prove to be long-term growers in Cornwall and across the country will need to change their production methods to match the new growing conditions, although seasonal extension is likely to feature heavily no matter what crop is grown. With Marks & Spencer now offering British melons who knows where the future lies!

In Cornwall, growers select the most favourable sites for production in the coldest months – the Golden Mile at Gulval, Penzance and other south facing areas close to the sea provide the safest, and the earliest crops.

6.3 Varietal Selection

Variety selection is extremely important for early crop production. The number of days from planting to maturity varies from cultivar to cultivar, and there can be marked differences in the ability of a variety to perform in colder and wetter soils and with lower light levels. Early-maturing varieties can however often have lower yields than main-season crops and quality may be lower, although this is often a worthwhile trade off for the early access to markets.

Early and late varieties are available for all vegetable crops, although development of new varieties tends to be slow as the lower acreages of these crops grown result in less incentive for seed companies to invest in improvement. All the businesses that I visited during my study expressed a desire for new varieties that can tolerate colder conditions or lower light levels, particularly when producing field-scale vegetable crops.

Varietal Selection in the UK

Work on extending the season by variety selection is well underway in the UK, driven mainly by developmental work from seedhouses. In Cornwall the new pointed cabbage variety Monarchy can be harvested up until Christmas, a six week extension to the current season and a direct replacement for

Spanish imports. With further development in conventional breeding techniques it is likely that early and late varieties will be available in the near future for other vegetable crops.

6.4 Glasshouses

The ultimate seasonal extension technique is the construction of glasshouses. As weather patterns across the globe become more unpredictable and transport costs rise growers are beginning to move towards glasshouse production of high-value crops such as tomatoes, peppers and salads close to the marketplace.

In Devonport, Tasmania I visited Brandsema Farms, who have invested heavily in a glasshouse development that takes advantage of large quantities of sawdust waste generated from Tasmania's logging industry. The sawdust is burnt to provide heat, humidity and CO₂ for tomato crops, mainly destined for the Tasmanian consumer but also for export to mainland states. Using this technology the company is able to produce crops for twelve months of the year, in a climate roughly similar to the UK. It was very clear that there is a huge advantage to the company of the off-season production, as it provided access to market that would be unavailable if only growing in the main season.

Also in Australia, a AUD\$120 million, 35 hectare glasshouse complex has been proposed for Nowra, New South Wales, that could radically change the vegetable and fruit production scene in Australia. The complex will comprise 33.6ha of glasshouses, a one-hectare packing, grading and cold store centre and a 1.8ha research and development centre to test and develop plant varieties under Australian climatic conditions. It would be capable of producing about 8000 tonnes of tomatoes, 4200 tonnes of cucumbers, 3780 tonnes of yellow, green and red peppers and 840 tonnes of strawberries each year and employ 260 to 280 people. This is in addition to the 12-hectare tomato-growing complex on the Northern Tablelands at Guyra owned by the Costa Group. Large-scale production of algae for the manufacture of biofuels and other uses, and an aquaculture operation are expected to be added later.

In Pukekohe, New Zealand, the company NZ Hothouses grows a variety of salad and vegetable crops under 20 hectares of glass. The glasshouses provide shelter and warmth for year round production, and the company contributes significantly to New Zealand's self-sufficiency in these short-life products.

I visited a clear example of the value of investing in glasshouse production while travelling in France. In Brittany there are around 1800 growers producing around 50,000 acres of cauliflower for the Prince de Bretagne marketing group. These growers contribute 24 per cent of the group's turnover, while only 250 tomato growers accounting for 1000 acres of glasshouse contribute 50 per cent of group turnover. Brittany has a very similar climate to the UK, and there is no reason why such development and diversification cannot take place across the channel.

Glasshouses in the UK

I firmly believe that investment in glasshouses to protect horticultural crops is the best way to guarantee extended seasonal production. Closer to home I visited the Thanet Earth project in Kent, a joint initiative between a UK based marketing company (Fresca) and Dutch growers. The intention is to build 56 hectares (138 acres) of glasshouses which will be linked to a gas fired power plant. This power plant will generate enough electricity to power 55,000 houses while using the waste heat and CO₂ to grow tomato, pepper and cucumber crops. To date 25 hectares of glasshouses have been built, producing 2.5 million tomatoes, 750,000 peppers and 560,000 cucumbers every week. Thanet Earth will produce nearly 10 per cent of the UK's requirement for these crops throughout the year when it is complete, greatly reducing the distance the produce has to travel to the marketplace. In addition, the site is carbon neutral as the gas CHP plant has directly replaced power that was previously produced by coal fired power stations. With an investment to date of £85m this project does not come but cheap, but its early success shows that strong investment can lead to a profitable and sustainable method of seasonal extension.

Sadly this innovative project has already been pilloried in the media under the heading *"WELCOME TO THE FRANKENFARM!; This vast complex in Kent, the size of ten soccer pitches, will grow millions of tomatoes year round without soil. The answer to food shortages, or an insult to our palates?"* (Daily Mail, 12th June 2008). The Thanet Earth project addresses many issues, including food security, the environmental cost of food transport and the environmental issues of off-season glasshouse production by using waste heat from power generation to grow the crops, and as such this media reaction is disappointing.

6.5 Plasticulture

The term "plasticulture" is used to describe an integrated system that includes any soil or crop cover made from plastic. To further increase the advantages given by genetic material and geography many growers are using cloches, plastic covers and mulches.

Some advances in these technologies are being explored in Gisborne, New Zealand, where Leaderbrand are testing a wavelength selective plastic mulch on courgette and squash crops which transmits only non-photosynthetic wavelengths of light, therefore providing an increase in soil temperature of up to 6°C without permitting the development of weeds. The growth effects of different thickness of plastic are also being evaluated to ensure that the maximum benefit is gained with the lightest and therefore most cost effective material.

In the Loire Valley the French corn salad growers have perfected a technique of mechanically covering the seed beds with low hooped plastic tunnels. While expensive, the technology allows production throughout the year and it is from this area that most of Europe's requirement for corn salad is met.

6.6 Mulches

Plastic mulches have been used commercially on vegetables since the early 1960s for both weed control and for warming the soil to produce earlier crops. North of Auckland in Dargaville, New Zealand, sweet potato growers use a black mulch to heat the soil to give them both earlier and higher yielding crops.

Plastic mulches have helped growers in extreme northern and high-altitude climates to harvest heat-loving crops that were previously impossible for them to grow. In the UK and in New Zealand I saw examples of sweetcorn being established by sowing directly through a plastic mulch for an early crop.

Courgettes and squashes in New Zealand are planted through slits or holes in black plastic mulch by hand or with a mechanical transplanter, which allows a huge advantage with weed control on an extremely sensitive crop. Further covering of this crop with fleece or clear plastic provides protection from any light spring frosts. Soil temperatures under black plastic mulch during the day are generally 6°C higher at a depth of 2 inches compared with bare soil.

Clear plastic mulch allows far greater soil warming than coloured plastic, but will allow the development of weeds. Infra red-transmitting (IRT) mulches provide the weed control properties of black mulch, but they are intermediate between black and clear mulch in warming the soil.

Plastic Mulches in the UK

Currently a number of organic and conventional vegetable crops are grown on plastic mulches in the UK, including courgettes, sweetcorn and squashes. Further work is required to evaluate the potential for the use of IRT mulch and the benefits of biodegradable products that will mitigate the difficulty of disposal.

Other types of mulch are in use in the UK. Straw is commonly used to allow the field storage of carrot crops, and work is underway on paper and potato starch based mulches that can be ploughed back into the field after the crop has been harvested to allow easy disposal.

6.7 Bed Covers

Clear plastic bed covers and spun-bonded polyester fleeces are often used by growers to cover a planted crop to achieve earliness by protecting plants from drying winds and frost. Fleece is permeable to sunlight, water, and air, and provides a microclimate similar to the interior of a greenhouse. In addition to season extension, bed covers offer the advantage of pest exclusion, including rabbits, pigeons and insects.

Growers of corn salad in Salinas use bed covers, primarily to reduce the damage from pests but also to protect the crop from the damage of intense

sunlight. The timing of removal equally as important as the timing of laying bed covers, as crops can become too warm resulting in checking of growth.

A clear disadvantage of using both mulches and plastic bed covers is the cost and a management time of laying, removing and disposing of the plastics after use. Machines are commercially available to remove plastic mulch from the field and to roll and pack it into bales, but for smaller-scale growers this is probably not an option. Other obstacles to recycling include dirt on the plastic making recycling difficult, the high cost of collecting and sorting, and a lack of reliable recycling outlets, although development of biodegradable bed covers may reduce this problem.

Bed Covers in the UK

In the UK, and in Cornwall in particular, a great deal of investment goes into plastic covering brassica crops and early potatoes to bring maturity forward as far as possible in the spring. However, the consumer does not see this benefit having a seamless supply of products with the gap bridged by Spanish & Portuguese imports during April and May. Supermarket insistence on 'availability at all costs' dilutes the success of much of this work.

6.8 Polytunnels

Polytunnels are used by many growers as essential tools in their operations to ensure continuity of supply. Polytunnels are arched or hoop-shaped frames covered with clear plastic and high enough to stand in or drive a tractor through, and have the advantage of being relatively inexpensive compared to greenhouses. Crops are grown in the ground, often with drip irrigation, and certain crops can be grown throughout the winter, providing a continuous supply to markets the entire year.

Crops that are often grown in polytunnels tend to be high value salads and fruit which are sensitive to extremes of weather and pest damage in open field systems. Organic crops are often also grown under polytunnels to reduce the risk of loss from pest damage. On average, polytunnels permit planting about three weeks earlier than outdoor planting of vegetable and salad crops. They also can extend the season for about a month in the autumn.

Polytunnels tend to be used more by smaller growers and market gardeners who have a direct route to market. Large commercial growers and packers will only use polytunnels where there is no possibility of geographic sourcing of outdoor crops, or where glasshouse construction of is not commercially viable.

Polytunnels in the UK

Polytunnels are used for a variety of crops in the UK, mainly soft fruit production. There is some public resistance to the use of polytunnels, with some high profile campaigns to reduce their use particularly in the larger fruit growing areas. Their use will not allow extension to the season of field scale

vegetable crops, although many small scale growers and organic producers use them for higher value crops such as leafy salads, tomatoes and cucumbers.

6.9 Other Methods

There are a variety of other smaller-scale methods of seasonal extension, from irrigation to reduce frost damage to temporary or permanent windbreaks.

In California, much investment has gone into developing ice slurry methods for long storage, such as clam-shell machines which inject ice into waxed cardboard broccoli trays. Such machines, as used by T&A produce in Salinas, allow field heat to be removed in seconds, and the extension of storage life has opened up valuable export markets to Japan and further afield - in 2007 two jumbo jets full of broccoli were flying into Heathrow each day after crops in Lincolnshire were devastated by floods.

With the weak pound, export markets for UK vegetable products might become viable and techniques and technologies for extending storage life will be required.

These technologies may also allow us to add two weeks to the end of the season by storing the last of the autumn crops.

The secret to success in lengthening vegetable growing seasons with all of the methods outlined above is to find the point at which the extent of climate modification is in balance with the extra amount of time, money, and management skill involved in attaining it.

7. Conclusions and Recommendations for the UK

There is little economical sense in trying to produce vegetable and salad crops out of season when to do so will result in low yields and costly inputs. The case for seasonal extension needs to be made by an assessment of the economical and environmental implications of low-input, high transport imports against high-input, low transport home-grown produce. The cost and effort involved in extending the season also needs to be recognised by the customer in terms of promotion and remuneration.

Recommendation 1. Use of technology

Seasonal extension methods should be employed by growers wherever economical to ensure that UK grown vegetables are available for as long a period as possible.

Testing of new plastic covers, cloches and fleeces under UK conditions is essential, including trials of the wavelength selective IRT mulch detailed above.

I firmly believe that the development of combined heat and power glasshouse developments such as Brandsema Farms in Tasmania and Thanet Earth in Kent have the most potential for season extension for UK vegetable growers. Thanet Earth has proven that it is possible to run a profitable business requiring high levels of investment despite the low margins associated with supplying the supermarkets. Pressure must be placed on the supermarkets to reflect the true costs of production in both retail prices and returns. In addition, during discussion with Thanet Earth it became apparent that the finance had been provided by a Dutch bank as the UK banks were not interested – perhaps this will change once the UK based banks see the proven success of Thanet Earth after a few more seasons.

Seed companies should be encouraged by the industry to develop improved early and late varieties wherever possible, and I am currently using my position within the seed industry to influence this.

In discussion with growers across the World it is apparent that many believe that genetic modification is the most likely route for cultivar development that will allow the production of crops outside of current seasons, particularly in the case of field scale vegetables and salads. Vegetable crops could be modified to allow increased tolerance of low temperatures and light which would allow production without the need for investment in plastics and other labour intensive methods.

Genetically modified crops are not permitted in Europe in due to both political and consumer resistance. However, work in this field continues in other countries and UK growers should keep a very close eye on GM developments in preparation for such a time as they are able to make use of them. Currently available genetically modified varieties include a sweetcorn that contains a gene present in *Bacillus thuringiensis* and can therefore create it's own insecticide, and a tomato that has delayed ripening which increases the shelf-life.

Recommendation 2. Abandon 'availability at all cost'

The requirement by the supermarkets that vegetable and salad lines must be always available dilutes the success of seasonal extension.

For example, early green cabbage can be brought forward to the first week of May in Cornwall using plastic bed covers, an extension to the season of some 3 weeks. However, the consumer is unlikely to be aware of this achievement as the gap in UK supply from mid March is currently filled with Spanish and Portuguese imports. In every other country I have visited the supermarkets do not require availability at all costs in extreme circumstances such as these, and when a product is short due to weather effects other product lines are promoted until availability picks up again.

Industry bodies and crop associations in the UK should do all they can to educate consumers about the value of seasonal UK vegetable production. For example, in Australia the Melbourne Market Authority issues a leaflet clearly showing the months when vegetables from Australian growers are plentiful, scarce or unavailable. This simple tool could go a long way towards raising customer awareness of seasonality and highlighting the value of early and late crops. Consumers should be given a choice, but not at the expense of home-grown produce.

In the Salinas valley an annual festival called the 'Salute to Agriculture' is held each September, with bus tours to growers, celebrity chefs showcasing recipes with seasonal vegetables and a raft of industry awards. By profiling the crops that are in season customer loyalty is created and appreciation of the seasonality of vegetable crops is achieved.

The supermarkets must also recognise the costs involved in producing these early crops, as current prices tend to be static across the season, neither rewarding those growers who both invest nor reflecting the risks the growers take in trying to achieve early production.

Recommendation 3. End promotions on imported produce where a British alternative is available

The supermarkets should stop promoting imported produce where it leads to the detriment of a UK grown equivalent.

Spanish grown broccoli is usually on promotion through the winter months when UK grown cauliflower is available. Tesco sales data clearly shows that sales volumes of products on promotion far outstrip near alternatives regardless of the origin. As a result of this promotion in the winter of 2007 British cauliflower was being ploughed in, with at least 3 million heads lost in Cornwall alone.

Pressure should be placed on the retailers to recognise the need to market British produce at a fair return to growers before promoting imported equivalents.

Recommendation 4. Redefine the term 'local'

All UK vegetable crops are grown primarily in the areas to which they are most suited. Thousands of acres of crop are required to support the infrastructure required to wash, grade and package the products. Consumer confusion is generated by the insistence of the multiples that small areas of vegetable crops are grown around the UK to satisfy a perceived demand for micro-regional produce.

To this end the industry must engage in a thorough, science-based calculation of the environmental and economical impact of food production per unit produced rather than rely on the blunt tool of 'food miles'. To send locally grown cauliflowers to Cornish supermarket stores in a small van would

create over 250 'food miles'. The distance to the Bristol distribution depot is 400 miles, but as the vehicle is travelling to the depot anyway the 250 miles can be considered additional, with increased congestion on the roads, at the stores and at the packhouses. A science based analysis of the carbon emissions involved in each delivery method could easily identify the best, both in terms of environment and finance.

Such a model would also reveal the benefits of seasonal extension projects such as Thanet Earth, and would also clearly highlight which vegetable or salad crops it is beneficial to import from abroad when seasonal extension is either impossible or economically unsound.

It is worth noting that other countries treat the notion of 'local' production differently to the UK. For example, when the American owned Whole Foods Market opened in Kensington High Street in 2006 it began selling UK grown product under the banner 'local'. Following protests from other retailers the company pointed out that the distance from Land's End to John O'Groats would comfortably fit within the state of California, and therefore any UK grown product satisfied their own criteria for 'local' produce.

Recommendation 5. Work together

The investment required to grow crops in the UK outside of the traditional season will often only be possible where growers join forces.

In France, the strength of the Prince de Bretagne group has allowed much diversification and development, and has allowed the organisation to access finance for glasshouse development from Europe that would be unavailable to individual organisations.

In Costa Rica I visited a small co-operative of 70 coffee growers on marginal land outside of the main coffee growing region. By pooling their resources these growers have managed to invest in machinery and marketing and from a small base now struggle to meet the market demand they have created.

In Australia there are calls for producers to form a marketing alliance and create outlets for their produce to ensure a fair price for the producer and an alternative for the buying public to supermarkets.

8. Summary

In the end, I have finished my Nuffield Farming Scholarship with a broad appreciation of the challenges faced by vegetable and salad growers across the globe. I have seen first hand new production methods and techniques for ensuring maximum self-sufficiency while maintaining sustainable businesses, and on my return I have passed on this knowledge to my clients. By keeping in regular contact with the people and businesses I have visited during my travels I have continued to further my knowledge of both growing techniques, new products, varieties and ways of extending the seasons, and aim to continue to develop my understanding for the benefit of the industry as a whole.

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