Nuffield Farming Scholarships Trust

A Horticultural Development Company Award

The Study:

Vegetable Innovation and Processing

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Contents

1. Biography

I have been involved in Agriculture and Horticulture most of my working life. I left school at sixteen and entered into Agriculture. My passion was initially livestock farming and I soon realised that to progress I needed a formal qualification to enable me to develop and further my career. My immediate family were not involved in Agriculture so I heading off into the unknown! I enrolled at the Lancashire College of Agriculture (Myerscough) in 1988 and spent three years studying and National Diploma in Agriculture. This was a sandwich course and here I experienced arable and small scale vegetable farming. After many years of wanting to pursue a career in livestock farming I suddenly realised a whole different industry with regards to food production. In 1991 on completion of my diploma the milk industry started to decline and falling milk prices made me hesitant to continue my dream of dairy farming. Opportunities were now few and far between as feed manufactures and dairy farms were scaling back.

In search of employment I was lucky enough to be recruited by a large Vegetable growing and packing company which supplied a wide range of vegetables to the supermarkets. I spent twelve fantastic years working at the cutting edge of supply to all the leading multiples. I enjoyed many technical roles within the company and it was here that I trained as a vegetable agronomist and my passion blossomed for growing vegetables in the UK within a large vegetable production company supplying the major multiples.

After twelve very enjoyable years I left the company and formed by own consultancy company – Agritec International Ltd, and today the company advises on all aspects of vegetable production from growing to processing.

My business is diverse – from agronomy to vegetable processing. We offer our clients a service which can only be described as 'From Seed to Shelf'. Over the years we have developed a nucleus of clients who are market leaders within the industry. Our consultancy company has helped to steer businesses towards unique opportunities within the market, and enabled them to gain the competitive edge.

I represent my industry as vice chair of the British Carrot Growers PR group which actively works together to promote British carrots to increase consumption and penetration in the market. This is supported by the growers and packers of the UK and also by the Horticultural Development Company.

I really wanted to further my knowledge of this industry and I thought that the Nuffield Farming Trusts would be a great way of doing this. When you are a small business it's sometimes very difficult to challenge the way you operate and also to develop new and fresh ideas. My business has been built on innovative solutions for the vegetable industry so I knew that Nuffield would be a fantastic way of doing this. I am very grateful to my sponsor the Horticultural Development Company who for many years I have admired for there world leading research and development in Horticulture. May I also take this opportunity to thank all the team at Nuffield for their encouragement and their continued support and leadership over the last two years.

2. Background to the Study

Vegetable innovation and processing plays an imperative role to my business, therefore I wanted to further my involvement and knowledge of the industry - not just on a UK basis but on a global scale. We are all aware that vegetables, if consumed as part of a balanced diet, are extremely beneficial for our health. However on average we only eat approximately three portions of our recommended five portions of fruit and vegetables each day. There is still a huge potential for growers, suppliers and retailers to ensure that we consume our recommended portions. Innovation needs to be the key driver which enables more produce to be consumed and this is only delivered by means of either new or modified processes.

My Scholarship took me to the USA, Mexico, Holland and Belgium looking at vegetable growers, processors, shippers and machinery suppliers. It was quite clear to me that in order to increase consumption of vegetables here in the UK I wanted to understand the global picture and to evaluate leading countries and understand their mechanics to drive healthy eating initiatives, which in consequence would consume more vegetables. If, as an industry we could get consumers from three portions a day to four portions of fruit and vegetables it would be nice to think that at least 0.5 portions could be produced in the UK from UK vegetable farms. The problem with fruit is that approximately 60% consumed is imported and does not have any contribution to UK agriculture/horticulture.

Firstly I wanted to investigate reports that as a nation the '5 a Day' campaign was not actually working and that consumption was only around 3 portions. A portion is deemed as 80grams and potatoes do not count, as these have been categorised as 'Starchy Foods'. In the early days at the turn of the millennium the government through the NHS started the School Fruit and Vegetable Scheme.

The School Fruit and Vegetable Scheme (SFVS), is one aspect of the '5 A DAY' programme and provides a free piece of fruit or a vegetable to children aged four to six years, each school day. The scheme was originally piloted in more than 500 schools throughout England in 2000 and 2001, to examine the practicalities of the scheme before rolling it out nationally. It was expanded region by region with funding from the Big Lottery Fund; since April 2004 the Department of Health has been funding the SFVS, which is now operating throughout England.

The National Foundation for Educational Research (NFER), in partnership with nutritionists from the University of Leeds, was commissioned by the Big Lottery Fund to carry out an evaluation of the impact of the SFVS by monitoring changes in consumption, nutrient intake and attitudes to healthy eating in children from one region before and after they became involved in the scheme.

Two research instruments were used: a food diary, the Child and Diet Evaluation Tool (CADET) to measure food intake over one day, and a pictorial pupil questionnaire to explore children's attitudes, knowledge and awareness. Data was collected on three occasions from schools in the North East where pupils began to receive fruit just after the first (baseline) survey, and from a matched group of schools in Yorks and Humber, where the SFVS was not introduced until after the final survey.

Consumption
Overall, pupils consumed an average of 3.36 portions of fruit and vegetables a day, with only 27 per cent achieving the recommended intake of 5 A DAY
Girls ate more fruit than boys, and were more likely to achieve the 5 A DAY target

Girls also ate fewer snacks and desserts (a classification referring to food items such as cakes, crisps, sweets and puddings, not to the time of day at which they were consumed)
Pupils in schools with high proportions of pupils eligible for free school meals (FSM) ate less fruit and vegetables, more snacks and desserts; they were less likely to achieve the 5 A DAY target
Pupils in schools with high proportions of pupils with English as an additional language (EAL) ate more fruit and fewer snacks and desserts
Generally, fruit consumption decreased between Reception and Year 2, and older pupils were less likely to achieve the 5 A DAY target.

Analysis of the complete survey data also indicated that:
The combined fruit and vegetable consumption of children eating school dinners was greater than those who had packed lunches
Consumption of snacks and desserts amongst pupils who had packed lunches was much higher than those who had school dinners
Living in areas of high deprivation was associated with lower fruit and vegetable intake and higher consumption of snacks and desserts
Girls (but not boys) in the intervention group ate slightly more vegetables after the introduction of the SFVS
Over the lifespan of the evaluation, fruit and vegetable consumption of children in the intervention group declined at home and increased in school.

In the conclusions of the study the SFVS increased children's awareness of fruit by enabling them to try previously unfamiliar items. The scheme also significantly improved children's consumption of fruit, but appeared not to have any wider impact on diet. Increased consumption of fruit was not sustained when children's participation in the scheme came to an end. However, there was some evidence of increased knowledge of healthy eating, particularly in children from deprived areas.

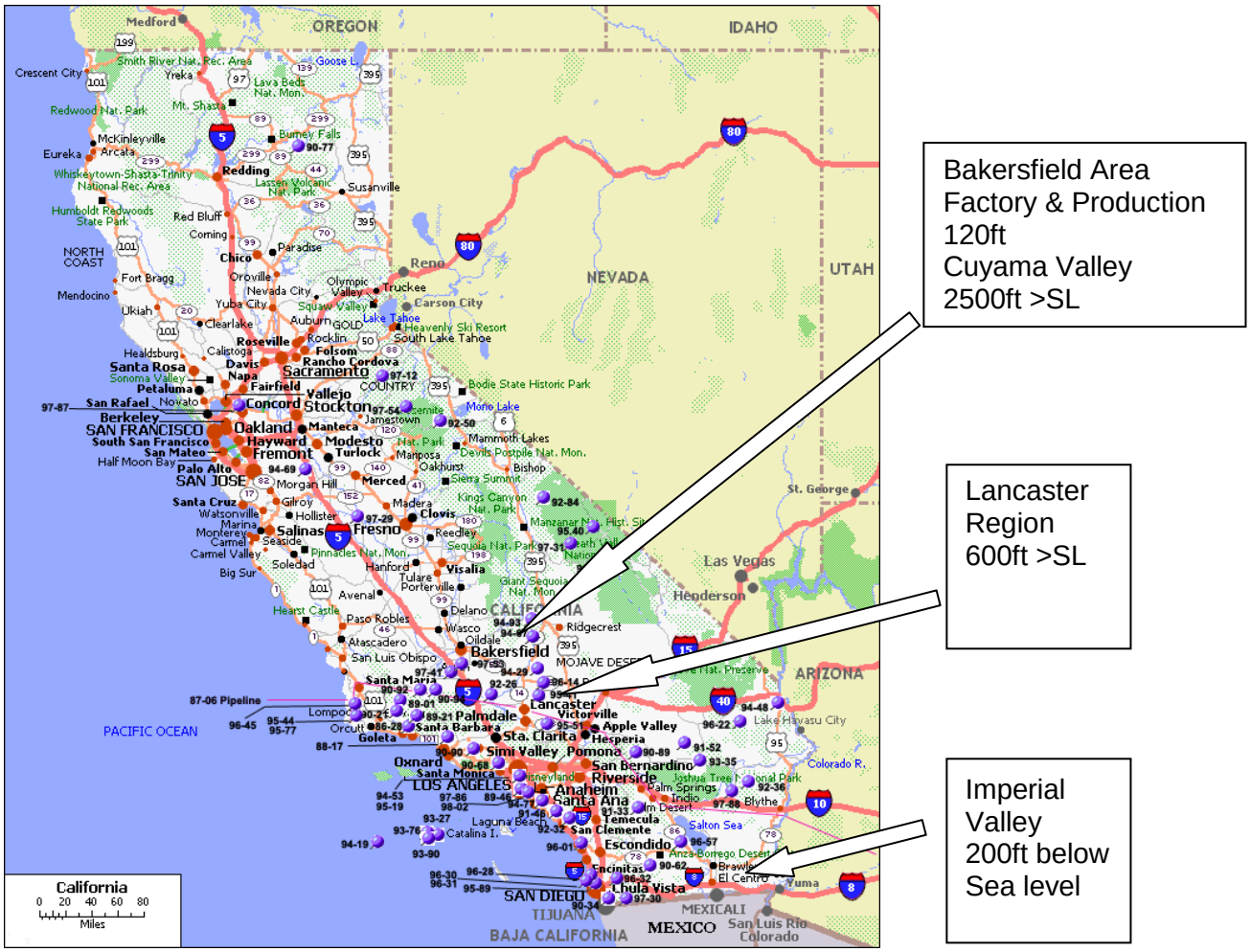
These conclusions basically admit that awareness is required with education and I firmly believe that a similar approach can be applied to adults. Adults know the benefits, however, they make an informed choice to whether they want to consume their '5 a Day'. Unfortunately children don't have this choice as they rely on their parents or guardians to do this on their behalf. I think that the SFVS has been a fantastic project however I believe that the root of the problem lies with responsible parenting. If vegetables and healthy eating is an everyday event at home children soon become familiar with this and adopt them into their diets at a very early age. Once children pass the age of seven and haven't had the opportunity to try the wide range of vegetables available, they don't take to the texture, smell and palate of them and usually this means that they grow up through childhood without consuming a healthy diet.

In the USA similar schemes operate and are directed by the USA government. The schemes are also embraced by the 'Center for Disease Control & Prevention' and also more actively by 'Fruitsandveggiesmatter'. This organisation is operated by the government and offers help and support for education to what foods and how much represents a portion.

3. Vegetable Production & Processing USA

My study tour to the United States of America focussed mainly on California. This State is home to approximately twenty five million people (nearly half the size of the UK). California produces eighty percent of the vegetables consumed in the whole of the US; I can only describe the scale of operations I have witnessed as 'mind blowing.'

One of the main companies I visited was **Grimmway Farms**. The company is situated in Bakersfield however they produce carrots in three main areas.



One of the fundamental factors crucial to the success of vegetable production in California is the near perfect weather conditions. The average year round temperature 18 degrees C , and over one hundred and nine days above 32 degrees C, ensure that vegetables grow very quickly and are much less prone to insect and fugal attacks, compared to production in Western Europe. The different production areas are used to create year round availability to ensure continuity of supply. In winter production moves down to the Imperial Valley which lies 200ft below sea-level. Carrots are harvested and transported back to the main packouses in the Bakersfield area.

The company was started back in the mid-1960s, when Rod Grimm, who was in college, and Robert Grimm, who was only in eighth grade, started farming five acres of sweet corn on their grandfather's chicken farm in Anaheim, California. Their first

employees were their cousins and two sisters, who sold the corn from produce stands along the roadside. Through the years, they added other crops, but by the late 1970s, Rod and Robert became deeply in debt. In the early 1980s, the brothers saw a promising future in the carrot farming business in the San Joaquin Valley, so they relocated to Kern County. After the concept of baby carrots was successfully test-marketed by another company in Los Angeles, it quickly turned into a race to see which processors could put in equipment fast enough to serve the emerging market, Robert Grimm later recalled. He considered the name 'a happy accident' for the baby carrots, while it did nothing to dissuade shoppers from thinking they were buying an immature root vegetable. By the mid-1990s, the company was able to process millions of pounds of baby carrots a day. Today they are the largest processor in the world and have now export products all over the world

In 1998, Rod Grimm died of cancer at the age of 51. Robert Grimm then took over as company president. A decade later Grimmway Farms began buying other companies, including two top carrot-packing firms, to become the industry leader. By 2000, they had reportedly grown into a $350-million operation with five plants in the United States and product shipped to more than twenty countries. Grimmway Farms have been recognized for boosting the sales of the baby carrot by positioning it as a healthful snack and packaging it in ways that make it easy to put in kids' pack lunches and serve on aeroplanes. Today, baby carrots account for about seventy percent of carrot sales at Grimmway; Kern County's largest employer with seven thousand employees. Grimmway and Bolthouse Farms, a competitor also based in Bakersfield, produce almost ninety percent of California's carrots. In 2001, Grimmway Farms purchased King Pak Farms. King Pak was a thriving potato growing, packing, and shipping operation in Edison, California.

On March 17, 2006, Robert Grimm, president of Grimmway Farms, died of a heart attack in his home in Bakersfield, California. Today Jeff Meger, the Grimm's nephew and company vice president, has taken over as the current president of Grimmway farms. The company handles approximately forty thousand acres per year which when compared to the whole of the UK industry is extremely impressive and gives some idea to the scale and operation. The UK industry consists of around ten key grower/packers and the whole acreage combined is only twenty five thousand acres.

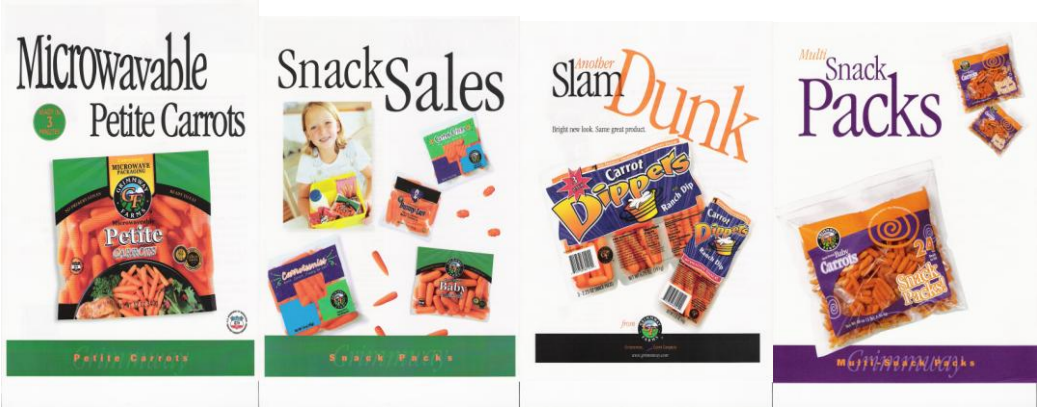
Innovation plays an extremely significant role for these market leading companies, and the majority sold all their produce through their own unique brand. Unlike the UK where the supermarkets dominate and call the shots - the US market is very different. Brand domination from the supermarkets on fresh produce is very small in the US, allowing suppliers to capture the market. These companies have invested millions on brand creation and they use this to drive their own categories forward.
The two major carrot producers in the US have captured ninety percent of the market with very little competition on the way. Due to the sheer size of these companies they often buy out the up and coming companies to enable them to stabilise the market and control price by means of current availability.

Cuyama Valley
2500ft >SL

Bakersfield Area
120ft>SL

Cuyama Valley carrot harvesting at nine acres per hour

Below are some of the innovative ways in which the company has engineered its products so the get maximum penetration into the market and complete crop utilisation.



The inclusion of vegetables in snack packs for children is a very fast and emerging idea in the UK. However, in the States it has been common practice for many retailers to stock such items. Apple slices, carrot sticks and celery pieces are an ideal way (if portioned correctly) to ensure that children snack healthily at school or at home. Using special techniques - such as cartoon association with super heroes, children will consume these snacks as they are encouraged by their cartoon heroes. In the States I also saw more encouragement by adding caramel as dips. Although it

is not ideal to consume sugar snacks with fruit and vegetables, consuming one portion of the vegetable or fruit snack far outweighed the sugary bribe!

The use of cartoon characters is an instant appeal to children and the Grimmway brand 'Bunny-Luv' is recognised around the supermarkets in the US. These packs are very innovative for the following reasons.

*Peeled and ready to eat (either hot or cold)
*No wastage or preparation for the consumer
*4 individual packs within a bag each 3oz (80grams equivalent to a portion)
*Cartoon illustrations encourage children to try
*Long shelf life – packaging helps to reduce moisture loss, so they remain fresh and crunchy

Bolthouse Farms – Bakersfield
This company is very similar in size to Grimmway and has similar diversity of products and similar growing areas. Bolthouse also produce thirty five thousand acres and between Grimmway they control 90% of the carrot market in the US.

I visited the main baby carrot plant at Bolthouse Lane and spent most of my time with Robert Nugent. Robert is the production manager at the site and controlled everything from the office. Every single motor or variable speed could be altered via the main program and feedback of tonnages passing through the line were digitally displayed. The automation of the plant was very impressive and there were very little operatives in the main factory as camera graders were used to take defect material out.

Bolthouse Farms have pioneered the production of carrot juice. They have invested millions of dollars in their new processing factory at east Brundage Lane. They have probably one of the best clean fill lines in the world and this can give the juice the forty day + shelf-life. This stabilised shelf life has enabled them to distribute the product around the US to ensure it remains as the number one carrot juice brand

The juice is made from parts of the carrot which are not used for the snacking market giving them a maximum utilisation from the product. The flash pasteurisation process ensures that the microbial activity is greatly reduced however it is impossible to remove everything from the product. The higher the temperature the greater the impact on the flavour profile.

Colourful Harvest – Salinas

I met with Casey Rose – Business Development Manager at the Freshtec Exhibition in the state of Nevada in April 2009. Their whole company philosophy was to produce innovative salads and vegetables to stimulate and create interest. Casey told me that functional foods were high on their agenda and they tried to produce vegetables which were high in antioxidants. Colorful Harvest Sweet Red Corn is rich in important phytonutrients and gets its deep red colour from antioxidants called anthocyanins. The product looked absolutely amazing and when cooked the corn turned deeper red.
Colorful Harvest Rainbow Crunch Carrots are also very unique, traditionally bred and are available throughout the year in shades of red, orange, tangerine, yellow, white and cream. They are super sweet and you can imagine the appeal they have to children. These heirloom style carrots have a full spectrum of important vitamins and nutrients including the antioxidant lycopene which is mainly found in tomatoes.

Coloured vegetables are also very new in the UK; however the US uses this unique and novel idea to promote and entice children into trying vegetables (maybe for the first time!) Ruby Red sweetcorn, yellow carrots, purple cauliflower may all seem very far fetched, but children associate bright colours with sweet things, and so they are intrigued and will try them.

When designing new products portion size is a huge contributing factor to the successful launch. Too much and children will not finish the pack and will be put off for next time, too little and the pack may look expensive and therefore will not make it onto the weekly replenish list. In the UK eighty grams is considered to be the correct amount for the product to be sold as one of your five a day portions. It is no surprise to see that some of the market leading companies spend millions with the message 'Healthy Snacks – convenient for Moms and Kids!'

For the processor healthy snacks can be a fantastic opportunity to increase the revenue of a low value product. The majority of carrots, celery and some fruit can be prepared from product that does not meet the stringent quality standards for the retailers. The preparation method can take away any skin blemishes and the product can also be cut to size. This means that produce can be changed from low value to high value by means of a simple process. If the product is packaged correctly and the target market is right the process can be very lucrative and carrots can be sold at £10,000 per tonne!

Ready Pac Produce Inc. Irwindale

Based in Irwindale in the heart of Salinas Valley, Ready Pac Produce are one of the leading prepared salad and vegetable processors. They have many product lines and the facility is extremely modern and built to a very high standard. Their range and brand is well known around the US and sales are currently growing at twenty one percent year on year. Their approach to all their products is based around pure conveinence and preservative free. They adopt gas flushing techniques and use modified atmosphere packaging to allow the respiration rate to be controlled. With all prepared salads and vegetables, refrigeration plays the single biggest part in shelf-life.
Below are just a few of the very innovative packs which I saw:

Cool Cuts vegetables and dips which try to make vegetables fun for children.Using fresh carrots or celery sticks they add a ranch or peanut butter dips, they are intended as an excellent alternative to cookies, chips or candy. There are three 2.25-ounce, three-pack varieties which include: Carrots with Ranch Dip, Celery with Ranch Dip, and Celery with Peanut Butter. The cartoon association once again really helps to get the message across to children that it is 'really good' to try these

Spinach leaves and Leafy greens which can be microwaved

The product is stored in the refrigerator and then cooked in less than 3 minutes in the packaging.

The conveinence angle is delivered two fold:-

Ready washed and trimmed
No cooking utensils required. Discard packaging once cooked.

These unique and useful products are just what's needed when you think you are too busy to prepare a meal. They select the freshest vegetables and wash, slice, dice and prepare it so the consumer has no preparation.

Consumers can eat as they are or add further ingredients to create a meal.

San Miguel Produce Inc

Located on the coastal plains of Oxnard, California, the family of San Miguel Produce, Inc. have been farming for three generations. The company has created unique partnerships with friends and family - all sharing a passion for greens. San Miguel Produce are real innovators of Cut 'n Clean Greens and dominate the US market. They now pioneer the industry and are the market leaders for leafy cooking greens. In 1996, company founders took their appreciation for nutritious vegetables and their history and professional expertise for growing superior vegetables in California and combined them to create the very best, freshest and most nutritious varieties of packaged cooking greens in North America.

The vision of this company is to provide consumers with an easy solution for adding nutritious and freshgreens to their diet more often by eliminating the long and arduous task of picking, washing and cutting fresh greens. The company produces over twelve diverse and delicious varieties of Cut 'n Clean Greens.

I met with Jan Berk Vice President of the company who explained to me the whole concept of providing healthy vegetables in a format for meal solutions. The category has had good growth with the supermarkets and now competes with prepared salads on the refrigerated displays. Greens are renowned for their antioxidant properties, however marketing needs to be strong and powerful for new consumers to purchase the product.

Vitamin K	1045%
Vitamin A	308%
Vitamin C	58%
Folate	44%
Manganese	41%
Potassium	27%
Calcium	27%
Fibre	21%
Iron	12%
Vitamin E	8%

Collards are described as the world's healthiest food and the above nutrient table shows how 180g can contribute to the recommended daily intake of vitamins and essential trace elements. Collard have long been a staple of the Southern United States, unlike their cousins, kale and mustard greens, they have a very mild, almost smoky flavour. Although they are available year-round, they are at their best for flavour from January through April.

While collard greens share the same botanical name as kale they have their own distinctive qualities. Like kale, collards are one of the non-head forming members of the Brassica family along with broccoli and cauliflower. The dark blue-green leaves that are smooth in texture and relatively broad distinguish them from the frilly edged leaves of the kale.

Church Brothers Produce

Tom and Steve Church each began their fresh produce experience in high school loading lettuce during the summers in the Salinas Valley. They took similar paths through different sales desks learning the business and developing relationships with customers and growers. Their careers came together in the mid 1980's at Fresh Western Marketing, now known as River Ranch Fresh Foods. Tom and four other partners formed the company in 1981. Steve joined the team in 1985, after his career at Grower's Exchange. The River Ranch years were marked by innovative ways of approaching harvest, cooling, packaging and load consolidation. Unique ideas and passion for the work led to opportunities to flourish in field packed products and to initiate a fresh produce processing arm, Fresh Valley Produce.

Church Brothers Produce is in alliance with True Leaf Farms, a processing entity currently producing a variety of spring mixes, spinaches and whole leaf singles of Romaine, Green Leaf and Red Leaf. True Leaf Farms operates seasonally in San Juan Bautista, California and Yuma, Arizona.

I met with Ernst Van Eeghen – Director of Marketing & Product Development and he explained the recent exciting news that Church Brothers Produce and True Leaf Farms had formed an alliance with Imagination Farms.

Imagination Farms has always marketed fresh produce and now had secured the agreement with Disney to start a new range of prepared ready to eat healthy snacks to create Disney Garden Products. The agreements with Church Brothers, and True Leaf Farms, enabled both companies to tap into the potential and volume of branded Disney products overnight. Church Brothers were now supplying Disney Garden commodity vegetables from its operations while True Leaf supplied Disney Garden bagged vegetables, bagged salads, and unique vegetable products designed for children.

Imagination Farms is a national fresh produce marketing company founded with the mission of increasing the consumption of fresh fruits and vegetables among children. The company is now one of the only companies marketing the Disney Garden brand of fresh produce, offering both organic and conventionally grown products. Imagination Farms offers a comprehensive assortment of innovative products and creative packaging. As a marketing company they work closely with their suppliers to ensure complete integrity of the branded products. I didn't manage to meet up with Imaginations Farms when I was in California however Ernst explained in detail the process and licensing agreements.

Imagination Farms was recently awarded the Disney Consumer Product Award for being an outstanding licensee. Their vision was recognised for outstanding contribution to the industry and they were rewarded for staying true to the mission of increasing the consumption of fruits and vegetables among children.

The whole concept of using cartoons and Disney branded products to increase consumption among children must be seen as a positive. Licensing agreements were not discussed due to customer confidentiality however I would suspect that it would be very expensive to use the Disney logo on the packs. The initial uptake of packs has been extremely surprising, however I was told that more work is required regarding the positioning within stores and also point of sale material was required to ensure that the products were recognized not just by children in store but by parents.

Sakata Seed America Inc.
Whilst in the California area I managed to spend some quality time with Sakata. This is a Japanese company however they operate on a global scale and have offices across every continent of the world. I was very interested to interface with the company as I had researched that they had invested recently in a new carrot breeding program and some of the new varieties were now coming through the field plots.

Columbia is an Imperator type carrot developed for the cut & peel market. The roots are 9 - 10" in length and are cylindrical in shape, resulting in more cuts per acre. It has a smooth exterior, indistinct core and crunchy texture. It offers a sweet flavour as well.

Copperhead is a nice variety for any cut & peel growing area. This variety offers good yields with its slightly tapered roots and semi-blunt tip. Copperhead has vigorous tops, great root length, and colour.

Spearhead This widely adaptable hybrid carrot is ideal for the cut & peel market. Spearhead offers excellent yields in both size and cuts-per-acre. It also has very good strong tops.

Trinity is an excellent peeler that has shown good results in year-round production. This variety offers high yield potential and good crown attachment. It is 10-12" in length and 1/2- 3/4" in diameter, perfect for the cut & peel market. Trinity has good colour, texture and flavour with very good cracking resistance in all conditions.

Triton This new carrot from Sakata is known for its superb taste and texture. Triton has medium tops that are erect and dark green in colour. Roots are 9-10" long and 1/2-1" in diameter. This carrot is medium orange and quite cylindrical in shape with a semi-blunt tip.

Zeus An exciting new cut & peel variety from Sakata's carrot program, Zeus is a nice tasting carrot with good texture, size and "peeler" shape. Zeus has medium, light green tops. Roots are 9-11" long, 1/2-1" in diameter with medium orange colour and are slightly tapered with a semi-blunt shape. Zeus is tolerant to Alternaria leaf blight.
To summarise I would recommend the Triton and Zeus for the UK market. Triton proved itself with the taste and for UK conditions the ability to have resistance to Alternaria would make this variety more suited to environmental growing conditions in the South or North of the UK. Although Sakata have many breeding programs running throughout the world they are a particular strong player at brassica breeding.

My visit only focussed on carrot breeding in this particular area of California as I believe that some of the varieties they have selected offer a real point of difference in relation to taste and texture. I am very grateful to the help and support that Dan Remo – Assistant Area Manager for Sakata Seed America Inc. showed to me during my visit and also time spent with Kraig Kuykendall Area Manager at the 33rd International Carrot Conference in Anaheim California.

Nunhems Inc.
Nunhems, a subsidiary of Bayer Crop Science, is the global specialist in vegetable genetics and services. Nunhems lead the world in seed technology and production and are responsible for some of the major vegetable and salad crops of the world. They now supply some twenty eight crops and over 2,500 varieties, Nunhems have offices in all major vegetable production areas in the world.
I spent time in the Cuyama Valley California with Jay Shipman (Nunhems America Inc.) Here both Bolthouse and Grimmway were harvesting carrots. It was approximately a two hour drive back to the factory for processing. There were three varieties from many inspected which I thought had good potential for the UK market.

Sugarsnax 54 is very well suited for baby whole production because of its excellent culinary quality, smooth exterior and root shape. Sugarsnax 54 provides high quality cello carrots as well as sliced product. Its tender texture provides excellent eating quality however it can be brittle when harvesting.

TenderSnax has been initially developed to target smaller growers and local markets where more care can be taken with the handling and packaging of roots. TenderSnax produces tender, high quality roots that may not always hold up well to large scale mechanized harvest and washing. This variety will likely perform best on sandy and organic soils and for niche markets where high eating quality is the main objective.

Crème de Lite produces Imperator cello shaped roots with a consistent crème interior and exterior colour. Root smoothness in most soils is very good, texture is crispy, flavour is uniquely mild and sweet. Foliage is highly resistant to Alternaria and Powdery Mildew. Crème de Lite has shown remarkable adaptation especially for the "coloured" carrot class. It has been heavily trialled from the southern US and Mexico to the northern latitudes of eastern Canada and Europe. It has shown the ability to produce eye appealing roots, with little bolting and high yields in all areas and year around.

The carrots seen were
Very clean and almost had a golden appearance. Texture – very crunchy with a mild but sweet taste.

The tops were extremely healthy and showed no signs of alternaria

4. Carrot Production and Processing Mexico

Agropecuaria Sanfandila
The company is located in Lagos de Moreno in the State of Jalisco in Central Mexico. Lagos de Moreno lies 45Kms east of San Juan, right on the crossroads between Mexico and major cities such as Guadalajara and San Potosi. The State of San Luis Potosí is located in the west-central section of México. The capital city of San Luis Potosi is almost exactly the same distance from the three principal cities in the. country, MexicoCity, Guadalajara and Monterrey

The company, established in 1959, is a diversified agribusiness concern engaged in the production of table eggs, broilers, hogs and horticulture. Following a comprehensive restructuring, the company, now one of Mexico's most efficient table egg and broiler producers, focuses on the regional markets of Jalisco, Aguascalientes, Guanajuato and San Luis Potosi. The company has recently expanded into the production of fresh carrots and broccoli. At present all the vegetables are exported into the US market as returns are greater than those in Mexico and payment is guaranteed.

Mexico is a very populated country (eleventh in the world with 105 million people). Mexico City the most populated city in the world at approximately 20 million people. Seventy percent of the population live in cities, with the remainder living rurally. Mexico is the thirteenth largest carrot producer in the world with 378,517 tonnes of production. The USA is third with 1,601,790 and the UK is sixth with 677,144 tonnes. All the carrots which were produced by Sanfandilia were exported by truck to the US and sold to supermarkets and processors.

All carrots were either 'Bangor or Bastia'. These are two very well known varieties and are bred by the seed company Bejo in Holland. These varieties are renowned for their large crown and good weight. Total production was six hundred acres and average yields were around forty tonnes per acre (similar to the UK). However growing at altitude ensured that production could be difficult as extremely low temperatures in October and November highlighted the risk of heavy frost and therefore seedling damage. Like many countries carrots are a high input crop and also high risk and Mexico was no exception. Most of the carrots were being grown on bodied land and required up to 450mm of irrigation to deliver maximum yields. The yields were similar to that of the UK with one hundred and twenty tonnes per hectare quite common.

One of the main issues with the business was the amount of undersized carrots that were being produced in the attempt to produce large carrots for the export market. The company was in the middle of a large project to install pre-packing machines to pack the small carrots in order that supply could start to the Mexican market. Newtec pre-packing machines had been ordered from Denmark to automatically pack into 500g and 1kg individual bags. Whilst in Mexico I had the opportunity to visit some of

the potential customers in Mexico City, the largest being Wal-Mart. Our meeting was held at the main distribution centre for Mexico where we met up with Alberto Gonzalez Islas. He was responsible for the procurement of fruit and vegetables. Currently Wal-Mart sourced its carrots from many small growers around Mexico City. However quality was variable and supply could be intermittent. It was Sanfandila's aim and objectives to capitalize on the home market for maximum crop utilisation. The price was obviously much lower on the home market however to make the whole carrot growing enterprise work, maximum utilisation of the crop was needed and there was no way the export specification would deviate from the large specification it had demanded over the years.

5. Processing Machinery – Holland
Sormac

Within the UK the majority of processors use carborundam peelers to remove the outside layer of skin prior to further processing (slicing & dicing). Two of the most innovative peelers I saw had been designed by Sormac and both were manufactured using knife peeler technology. Both were suited to UK production as the majority of product peeled is now washed and pre selected.

Continuous Knife Peeler This peeler is capable of continuous peeling of pre-washed or pre-peeled root products, like potatoes, carrots, red beet and celeriac. The drum has several pre-peeling plates which replicate the effect of pre-peeling. The machine is constructed in a frame, with a peeling drum and an auger. On all sides the peeling drum is equipped with knife plates and is driven on both sides by means of V-belts by a separate motor. In the peeling drum the auger transports the product forward. The machine is equipped with a water pipe with spray nozzles. On the circumference of the conveying auger are spray openings, which make wet peeling possible. The peeling waste is transported away via the waste valve at the underside. The product diameter needs to be between 30 - 200 mm. It is also essential the product is pre-washed before it enters the drum. The machine would have many benefits for the UK market and it offers a real point of difference over traditional carborundam peeled products.

The knife peeler KP-60 is suitable for peeling long-shaped products such as carrots, salad cucumbers, white radish etc. The product to be peeled is placed on the infeed table and manually moved into the first pair of transport rollers, or onto the V-belt (option).The machine is equipped with nine pairs of transport rollers, which convey the product horizontally through the peeling machine. Pneumatic pressure holds the product in place as it is driven through the 8 knife holders, which are placed at different angles and peel the product on all sides along the circumference. The knife holders and the transport rollers are equipped with a quick release system, which allows easy removal for replacement or cleaning etc. The pneumatic pressure to the rollers is fully adjustable to suit variations in product sizes, this is easily accessible on the control panel. The peeling waste is delivered through a waste chute beneath the machine. The product needs to be between 15-60mm diameter however the minimum length is 150mm. The main advantages of this system are totally dry peeling, perfect peeling quality (as if peeled by hand), smooth peeled surface for extended shelf life, solid dry waste, easy to handle, hygienic design (easy to clean and disinfect), simple operation.

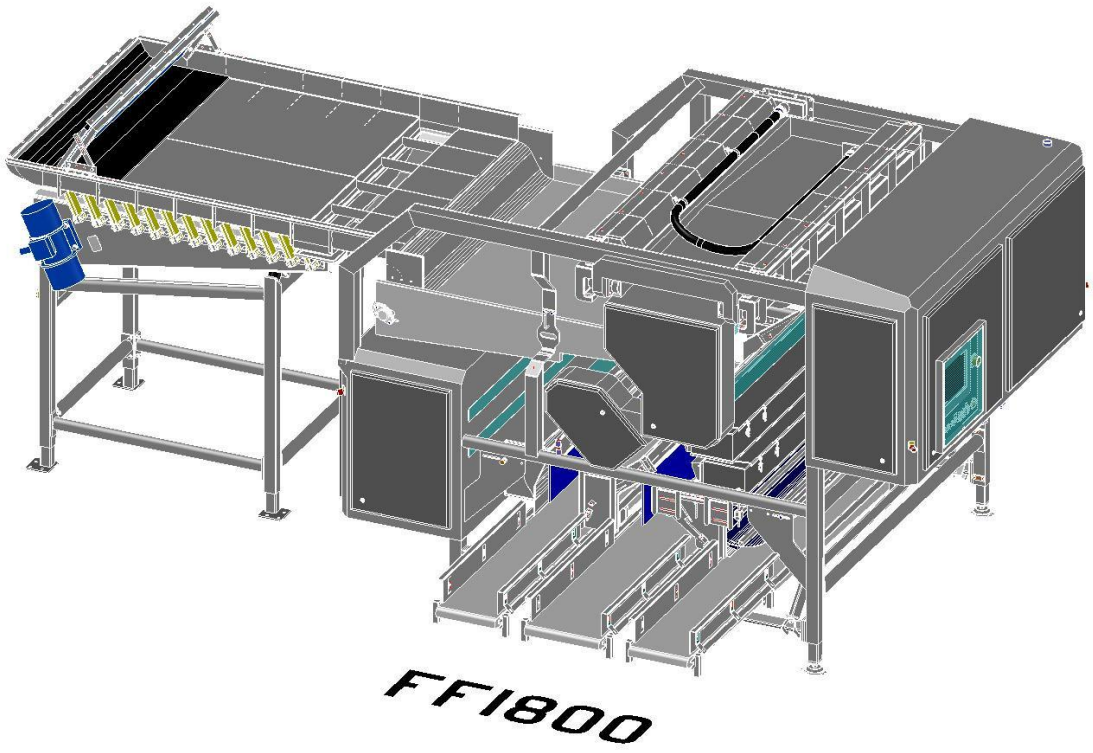
Automatic carrot topper – four lane machine consists of an infeed hopper with singulation system, a special conveyor, aligning belts and a knife platform. The conveyor is made of aluminium trays, which are mounted on heavy duty drive belts

on both sides of the machine. Mounted above the hopper is a unique driven levelling unit to ensure a single depth of carrots are delivered onto the stepped singulation elevator. The singulation system positions the carrots in the trays. These trays then pass over the aligning belts, which are mounted on the underside of the machine. The aligning belts transport the carrots firstly to the left and then to the right, where they are topped or tailed depending on orientation. The machine can be cut a wide range of sizes. Small carrot diameter 25 - 55mm or large carrot diameter 40 – 65 mm. Depending on the execution of the machine, it is possible to cut the carrots into pre-set pieces of minimal 40 mm (standard 50 mm). The machine will handle maximum length of 250mm

Sormac is leading the world on peeling technology and with Bert Haffmans as Managing Director and new owner of the business I am sure that they will have a great future within the industry. I have spent a lot of time with Bert over the last twelve months and his attention to detail and creation of new innovative methods of peeling vegetables is world class.

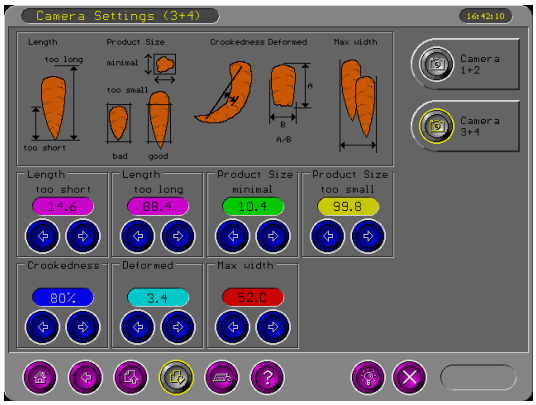
5. Processing Machinery – Holland
Concept Engineers

Concept engineers are based in Eindhoven in the southern part of Holland. They have been established for only eight years, however in that time they have launched many innovative machines. Their latest machine I saw in Holland the FF1800. This is the very latest machine which grades and ejects in free fall. The other very innovative design with this machine is that it can assess the products and grade into three categories. Class I and waste but also Class II.



The capacity per machine is approximately 15,000 kg infeed per hour (good and bad), depending on the size and with a maximum defect level of max. 30%. On the infeed vibrator the carrots will be spread over the full width of the vibrator and subsequently the optical sorter and will be aligned to have the best capacity. This

equal spread of the carrots on the sorter is very important to achieve an optimal sorting result. At the same time this vibrator can be used as a length sorter. The purpose of the infeed chute is to give the product the correct speed in order to improve stabilisation onto the product belt and to keep the product aligned. Then the carrots are distributed along the belt of the Free Fall and are inspected by 6 line cameras fitted with excellent lighting. The products will pass the cameras with equal mutual speed. The Free Fall is provided with special colour and shape recognition carrot software. In this way the cameras will identify the bad spots and foreign components by means of colour recognition and the computers will control the ejection unit for the removal of the rejected carrots from the product flow. By means of shape recognition the deformed, crooked, too short and broken carrots are detected. The approved product will continue its way along the production line for further processing.



Like all camera graders you must present the product to the cameras in line and uniform. If the carrots are bunched together then the eject mechanism could reject good product and this will in turn affect the overall packout.

At 15,000 kg per hour the machine is quite capable of fitting into most factories in the UK and to be efficient I would strongly recommend that all UK processors look at the potential long term gains in reducing labour inputs. At nearly £300K the machine is not cheap however the machine reduces the need of approximately eight employees. My calculations in labour savings ensure that the machine would be paid for in less than two years and therefore I would encourage all processors to look at such a system.

5. Processing Machinery – United Kingdom

Haith Tickhill Group

Haith Engineers was formed 60 years ago by Mr. Geoff Haith and is now one of Europe's leading manufacturers of root crop handling machinery, specializing in Grading, Washing, Bulk Handling, Weighing complete Pre-Packing systems and Water Treatment. Since its beginning as a small Agricultural Engineering company, the Haith Tickhill Group has continued to grow in size and strength so much that it has had to move on three occasions to larger premises with more production area, using the latest computer aided design and production technology at its head office and manufacturing site Armthorpe, Doncaster - UK. On visiting Haith Tickhill they have just invested in a new factory and have the latest plasma and laser cutters. I met with Nigel Haith (Geoff Haiths son) who demonstrated the latest features on their new RootVeg peeler. Within the UK industry only large scales steam peelers might

achieve tonnages of 6-8 tonnes per hour however with rising energy costs and high maintenance costs steam peeler is not the favoured option for many new processors.

They have recently launched the new RootVeg peeler for peeling vegetables using carborundum and brushes. This machine is quite aggressive as when vegetables are more than a few days old after washing they can develop a tough outer skin which is difficult to remove. The machine consists of a rotary drum with 14 and 18 rollers at 3 metre long. The patented roller design has a changeable carborundum section and varying grades of bristle. Configuration of bristle and carborundum length can be altered to suit a variety of vegetables.

By breaking the tough outer surface of the vegetable on the carborundum and then removing the skin with the brush section it peels and polishes the vegetable producing a smooth finish unlike produce which is peeled in a conventional carborundum machine leaving a very rough surface allowing bacteria to get in and cause break down of the vegetable. The machine can demonstrate up to a 95% yield especially on freshly washed carrots and therefore can retain an improved packout and retained profit for the processor over just carborundum peeling. The total output of the machine is obviously dependant on the quality of the vegetables being peeled however tonnages up to 8 tonnes per hour are very achievable.

5. Processing Machinery – Italy

Nilma
Nilma was established in 1960 in Parma. The company embraces issues and problems that have arisen throughout the food and vegetable industry. They have created solutions to some of the issues faced by all small processors, large kitchens and the professional catering industry by designing functional preparation machines from leaf washers, driers and cooking equipment. They focus on design and raise the qualitative standards, by respecting both the hygienic, nutritional and organoleptic aspects. Particular attention is focussed on the productivity increase together with labour and operating expenses savings, the control of expenditure and the rationalisation of work and working environment.

The above mentioned innovation takes advantage of the technical experience in the food industry machines of Mr. Pietro Nobili, its promoter. In the sixties, central production catering was in its early stages and Mr. Nobili realized this would be a developing market for specialized catering equipment. He was very confident and knew that this development was largely dependent on the solution that highly specialized technology could offer. This technology, being originated from a deep experience in the food industry, first of all bases on the knowledge of the product, of its characteristics and of the problems it creates. For these reasons, a solution is always innovative.

After looking around the factory and appreciating the full package that Nilma offer to the catering and food production factories I realised just how much thought, investment and creativity that had been invested into their range. Nilma are real pioneers within this industry and don't copy any other competitors product. I now really appreciate the quality of the equipment and also how different their products are to the competition. Nilma's vegetable & salad washers are completely different to the rest of competition in the market place for the following reasons:-

A perfect whirlpool - the traditional way of washing fruit, vegetables, meat, fish and frozen food is both time consuming and usually does not guarantee the removal of all

unwanted insects and dirt. The problem of washing large quantities without damaging the structure and quality of vegetables, salads, etc, is easily solved with the ATIR range of machines. Nilma have researched the various problems and have developed a system which uses an adjustable whirl or vortex with constant clear water. The water penetrates the product in depth and gets rid of all the impurities even from the most irregular of vegetables like spinach which has variance in leaf shape and density. The washing system differs from all the other systems I have seen mainly due to the holding and washing tank. The stainless steel tank has hundreds of small holes allowing the soil particles diffuse through into the waste and outlet pipe. This method allows the continuation of washing without further contamination.

6. Conclusions and Recommendations for the UK Industry

I have seen many field operations and processing factories on my study tour and I have witnessed how even the biggest producers in the world still innovate and apply every bit of effort to ensure that they remain competitive and are recognised as innovators within the industry. With large companies we sometimes think that they have used their brute force to push their way to the front, however within this industry it is quite the reverse. I have seen for myself that it is the attention to detail which propels a company forward and with the correct professionalism, a brand can be created fairly quickly if the market place is ready for the product.

Understanding and Capitalizing on the Market

In most cases the market is there –it just needs evaluating, developing and simplifying. The UK prepared vegetable market is still growing however it has slowed down very recently since the start of the recession. Consumers have started to move away from prepared to buy basic vegetables which they can prepare themselves. Here lies an opportunity to provide basic prepared vegetables at lower costs so when compared to whole product there does not seem any price difference. In the UK factories must continue to develop new lines and increase current volumes to move forward. Negative or static growth would be disastrous for most businesses. The UK must re-evaluate its product lines on prepared vegetables and deliver what consumers really want, whilst vegetables which have been air-freighted in and complicated meal solutions must be replaced with traditional home grown basic veg lines. I am convinced that this will strengthen sales and in no doubt will increase the bottom line for most producers. The strength of the Euro means that imports of vegetables from Europe remain highly priced.

Vegetable Snack Packs

An ideal way of increasing productivity for most producers is through the introduction of vegetable snack packs. Although only small single servings of eighty grams, the margin is much higher than larger packs and they are consumed more frequently. Penetration into this market is at the top of the agendas for most vegetable companies as the Government, NHS, and Schools push for healthier eating. Most schools now participate in fruit for schools schemes and recently the introduction of carrots as snacks, has boosted the industry awareness of healthy eating in school and at home. Multipacks should be sold more in the UK supermarkets. These would consist of ten times eighty gram packs. These would then be consumed over five school days for two children. The packs would then become a once a week shop item and a regular buy for most parents.

Brand Creation

My study has highlighted (especially in the states), that brand creation is essential as consumers buy trusted brands. For the UK market it is very difficult, however growers

may be able to work with smaller multiples or regional stores to launch and develop brands. We know how powerful brands can be if we get it right, when usually the multiples in question want to drop the line and re-instate with their own brand!

Value Added Products and Brand Association
Once branded products develop, I would like to see more brand association with larger brands to develop the category. McDonalds Restaurants have used this with their association with Cadburys to sell more deserts. I would like to see more salad packs associated with chicken, ham and egg producers. Brand association is an excellent way of propelling two brands forward at a much quicker rate, and it gives consumers real confidence.

Labour Reduction
As an Industry we are lagging behind some of the European countries (Holland and Belgium) with techniques for reducing labour. UK multiple specifications are probably the toughest in the world however new advances in camera grading and robotic stacking could make a huge reduction in direct labour. Few companies in the UK are taking advantage of this equipment; however the ones that have invested are now seeing massive benefits in reduced labour and overall efficiencies.

I have seen many different factories and processing units over the last 18 months and I can now begin to appreciate the real innovators within my industry. The most efficient and forward thinking companies are the ones that have invested in machinery and technology that reduces labour. Investment in labour is much more wisely spent in research and development and looking at innovative approaches within the industry to ensure that products being produced are different and have a real point of difference. My opinion is that if direct labour can be replaced by means of a machine then surely that this is progression in the right direction.

7. Summary

I have spent the last 18 months enthusing about what I have seen and know that there are some fantastic opportunities that await the UK industry. These opportunities are available to everyone it's just the forward thinking companies that will take these on board. I have seen many pioneering new processes and products and have witnessed how these have moved the vegetable processing industry forward. My main aim and objective is now to pass this knowledge and experiences back to my industry through my own network of industry customers. My Nuffield experience has enabled me to make life long friends and also a new platform to engage in industry networking and I am greatly appreciative of my sponsor and the Nuffield foundation for the opportunity I have been given.

I am truly convinced that the way forward for my industry is to offer its consumers a product that is healthy but more importantly in a format that makes it convenient and available for all.

- **Create** *(process)* – need for investment
- **Simplify** *(product)* – commonsense approach
- **Develop** *(consumers)* – opportunities

- Keep it basic, functional, prepared, convenient, healthy but more importantly **keep it affordable**

8. Acknowledgements

I would like to take this opportunity to thank the special people who have helped me to achieve my goals and aspirations. My Nuffield study has only been possible due to the continued support of my family and many of my industry customers. I have also met some amazing people resulting from my travels and I would like to take this opportunity to thank them for their valued help and support.

Special thanks go to the Horticultural Development Company for their sponsorship towards my scholarship and I hope that I can repay their generosity by fully supporting their work in the Industry.

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