

Section E: Extended Season Cropping Trials

E1 Project Background

Sustainable Uist received funding in April 2010 to carry out a Horticulture Research and Education Project on Uist during the 2010/11 growing season. As part of its original bid Sustainable Uist proposed erecting a greenhouse to carry out protected cropping trials, but this part of the application was turned down by the CCF assessor panel.

This was disappointing. The three main difficulties identified by Sustainable Uist as limiting successful vegetable crop production on Uist were:

1. The weather – particularly the wind
2. The poor soils
3. The short growing season

Whilst 1 and 2 could be dealt with by other means, a protected cropping facility was key to studying and educating new growers about the short Uist growing season. This has a significant effect on crop timings and outputs on Uist.

The table below offers interesting insight into the astronomical fact that whilst Uist enjoys long hours of sunlight in the summer – some 1½ hours longer than the south of England - in winter it is 1¼ hours less. This difference increases the natural seasonal time lag of soil warming in the spring and this problem is further exacerbated by the cool sea nearby and, in the case of the machair, light soil colour and composition.

Mid-summer	Sun rise	Sun set	Sunlight	Difference
Uist	0429	2233	18hr04m	+1hr27mins
Salisbury	0451	2128	16hr37m	
Mid-winter				
Uist	0905	1549	06hr44m	-1hr15mins
Salisbury	0806	1605	07hr59m	

e1 Sun rise, sun set and sunlight hours in Uist and Salisbury, Wiltshire

The resulting lower soil temperatures in May and June delay the start of the growing season by several weeks – probably between 6 and 8 – when compared to the south of England. Most commercial growers along the Channel coast would expect to be harvesting early spinach, beetroot, broad beans, salad onions and lettuce by mid May, whereas nothing much is ready on Uist until July. (An additional confusion for new growers is that most gardening books will therefore give incorrect advice on this topic when related to a Uist location).

However, the one seasonal advantage Uist does have as a result is that in the late winter/early spring, the relative infrequency of frosts, shorter days and lower daytime temperatures means that if winter crops such as roots and brassicas are in good condition, they can actually stand for longer than might be expected in the south.

These important factors supported Sustainable Uist's belief that protected cropping had to form a key part of its strategy to encourage Uist growers, so alternative funding sources were sought. Discussions with a Uist Councillor suggested that the Comhairle nan Eilean

Siar (Council of the Western Isles), Community Land Resources Development Programme (CLRDP) fund might be a suitable source. An initial call to the manager of the programme sounded hopeful and a follow up letter was then sent explaining the background and purpose of the project.

The main points in the letter were as follows:

- Benefits of adding a protected cropping facility to the existing horticulture trials project, particularly the importance of extending the very short growing season.
- Estimated cost between £15,000 and £18,000.
- Key decision to build a unique design using local materials and builders, rather than buy a pre-fabricated one from the mainland.
- Idea of extending the season further by lighting part of the greenhouse using a wind turbine.

This letter was followed up by a meeting with the programme manager and it appeared that if the project could be supported by local councillors, an application could be approved.

In the meantime drawings were completed, a planning submission made, tenders for materials and labour requested and a crop plan devised. With this material to hand a formal submission was made to the CLRDP on 15th June 2010 and approval was received a month later.

The 2010-11 project had four main elements:

- Designing and building the greenhouse – described below in E2.
- Designing and installing the lighting system – described below in E3.
- Devising a crop trial – described below in E4.
- Recording the results – described below in E5.

As the results from the first year proved interesting but inconclusive, and yet the main facilities were in place, it was decided to seek funding to repeat and extend the work in 2011-12. It was decided to focus the work on lettuce production rather than the other salad leaves and it was thought possible to target a total crop of 2000 lettuces over an 8 month period between October and April. This would require some additional investment including a larger turbine and more lighting. Community Energy Scotland (CES) kindly agreed to fund the former and CCF the latter.

The follow-up project in 2011-12 is described in E6 and the results in E7.

E2 The Greenhouse

E2.1 The Design

The original plan was to put up a Keder house. Recently, these have been increasingly used in the Hebrides because of their ability to withstand severe gales – which basic polytunnels are unable to do.

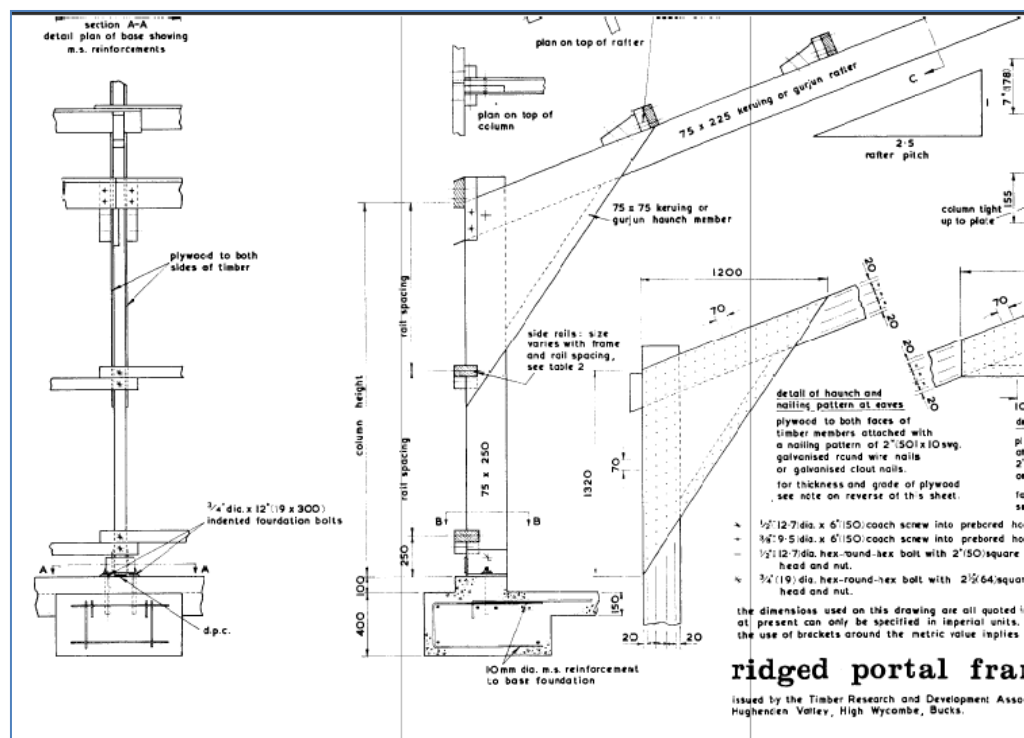
The initial inquiry to Keder was positive, and the budget right, but then came the news that they could not come to do the installation work until late spring 2011 because of a heavy work schedule, and their self imposed restriction of not working on the islands between September and April because of potentially difficult weather.

e2 Typical Keder Greenhouse



The only alternative was a self-design, self-build project.

In the 1970s the Timber Research and Development Association (TRADA, then a government funded body) came up with a simple timber portal frame building for use on farms for barns and sheds. The aim was to provide farmers with a simple, economic, DIY solution for large span buildings. The design principles are shown in the diagrams below.



e3

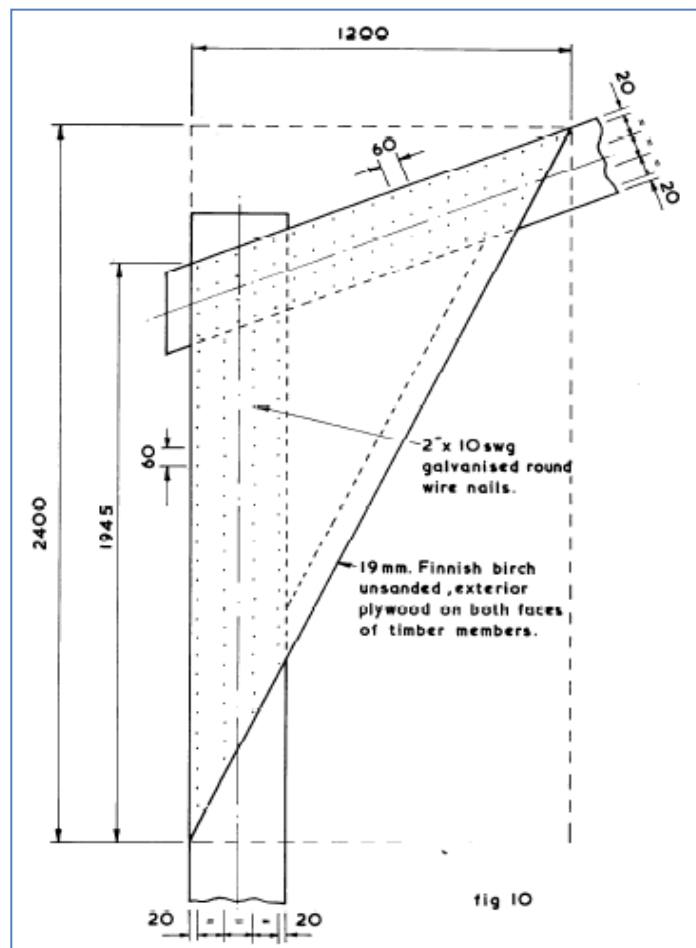
TRADA Timber portal frame building drawing

As well as providing simple detailed drawings the system document gave hundreds of timber sizes for frames, purlins and sheeting rails for different timber qualities, and different roof spans ranging from 6 to 15 metres. The system relied on very rigid connections at the ridge and eaves provided by nailed¹ double plywood gusset plates.

The advantages of the system were the avoidance of any specialist materials and/or skills as would be normally be required with steelwork designs. Claddings were expected to be corrugated steel or asbestos cement. The disadvantages were the need for rigid fixings for portal columns at ground level.

These buildings were popular in Scotland because of the availability of timber and a number were built by the then fledgling fish farming industry for shore base buildings in Argyll.

Using the TRADA tables a simple 8m X 12.3m building was designed for use as a greenhouse on the Liniclate trials site. Because of the exposed conditions, oversized gusset plates were incorporated to give completely rigid portal junctions.



e4 Nailing drawing gusset plate

¹ Hundreds of nails are required for each plate

The foundation situation was difficult. Concrete would normally be used as shown in the TRADA drawing at e3, but this building did not need a concrete floor. In addition, concrete work would be complex and expensive and take time, and access to the field for these heavy materials was poor. Finally, the building might only be used for a few years before needing to be dismantled, and, whilst the sheeting and framework could easily be taken apart, under the terms of the land tenancy agreement all of the concrete would need to be removed too.

With a deep sandy soil, the possibility of not having concrete foundations was looked at and discussed with an engineer. The feeling was that if a deep below ground extension to the portal columns was incorporated, with a plate support underneath and backfilled firmly, this idea should provide a satisfactory foundation. This is because of the rigid portal connections and heavy longitudinal bracing which mean that the foundations experience little or no lateral loads. The only additional need was some cross strutting underground to prevent up-lift. (see photo e5 below)

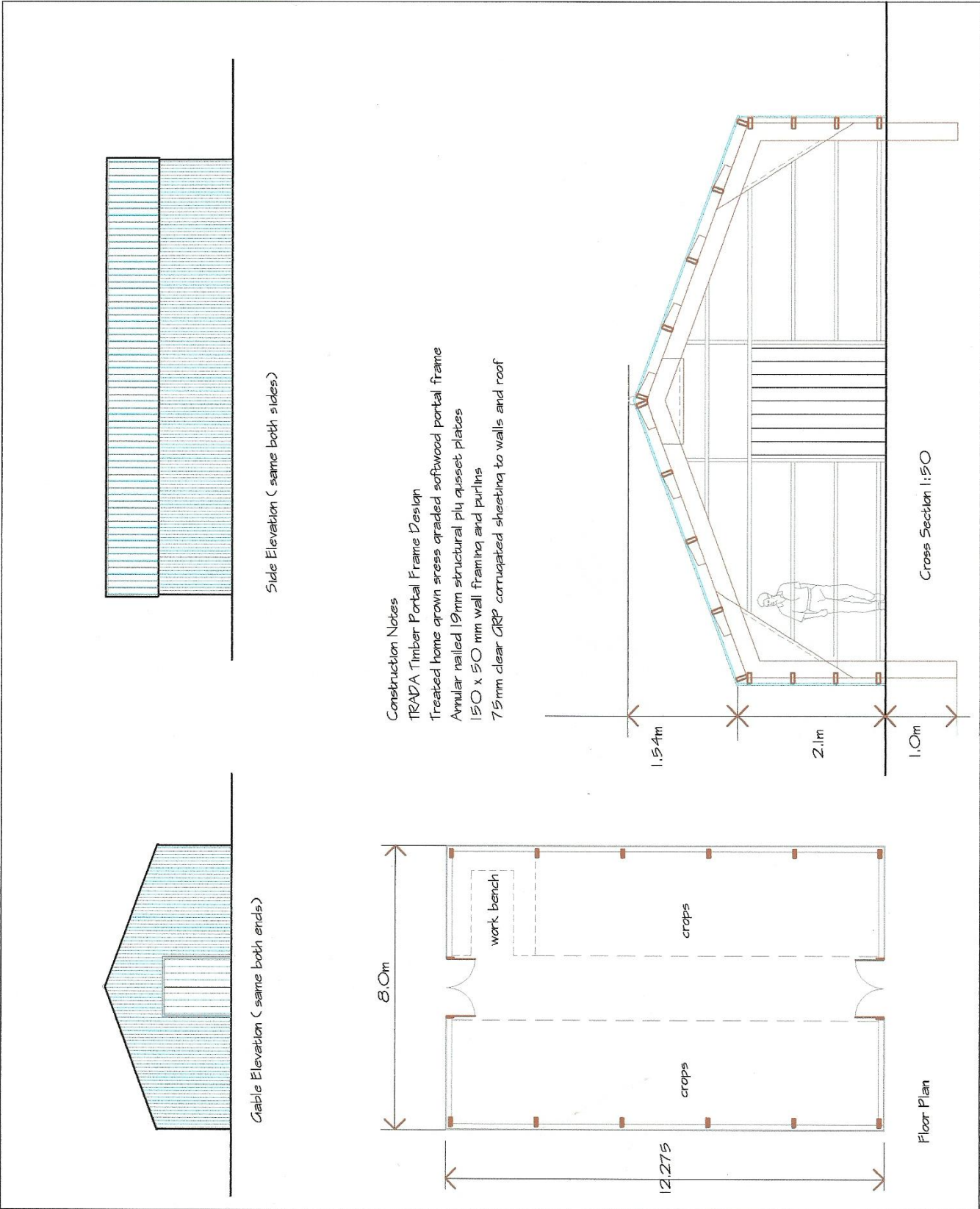


backfilling

e5 Foundation pit ready for

The drawings for the final design are shown at e6.

e6 Greenhouse design drawings



As an agricultural building on a site of more than 1 acre the building needed neither planning permission nor a building warrant². However, the planning authority does require to be formally notified using the Prior Notification procedure, but as this has a statutory period of 1 month, a quick response was received.

The location of the first greenhouse on the Linclate site is shown in the drawing below. The gable ends are orientated roughly ENE/WSW.



e7 Location plan of first greenhouse

² There are specific conditions needing to be fulfilled to categorise greenhouses as permitted development so potential builders should discuss their circumstances with their Area Planning Officer.

E2.2 The Building

The building took approximately 6 weeks to complete, working mainly at weekends and in the evenings.



e8 First frame



e9 5 completed

The first stage was to assemble the portal frames. This work was done on the ground. The first frame was set out very carefully and then acted as a template for the remaining five to be built on top.

After setting out the site with levels and strings, a mini-digger was used to dig the column holes and then each frame lifted up and lowered into place onto marine ply plates. These were packed up as necessary to achieve the correct level. On the site the sand is extremely hard at a 1m depth so there was plenty of good vertical support. There was a little ground water evident in the foundation excavations at the eastern end. The frame was temporarily braced to hold it vertical while the anti-uplift struts were nailed in place, and then the digger backfilled and compacted the holes. Then the next set of holes were dug, the next frame lifted into place and then one set of pre-cut sheeting rails and one of roofing purlins were nailed into place to accurately set the bay dimension.



e10 First portal frame in place



e 11 All in

This process continued until all the frames were in place and the complete structure was erected on a single Saturday towards the end of July.

Over the next week, the remaining framework was put in place. This included diagonal bracing to every bay to keep the whole structure rigid longitudinally. Then the wall and roof sheeting was fixed in place. A good quality translucent GRP sheeting was chosen and TEK drive screws used to fix it to the rails and purlins. GRP is the strongest translucent sheet that can be used and has good resistance to UV light degradation. The TEK screws ensure a very strong fixing with good waterproofing delivered from pvc washers.



*e12 Wall cladding
note diagonal bracings*



13 Cladding nearly complete

The final jobs included two sets of doors and ironmongery and two workbenches, and everything was sufficiently completed for planting out to take place on 1st September 2010.



e14 Just about complete



e15 1st September 2010

The building work could not have gone more smoothly. It was finished on time and slightly under budget. As soon as it was nearing completion it felt comfortable and light inside. The only omission was rainwater goods which it was originally thought were not necessary, but in heavy rain the water coming off the roof caused erosion of the sandy soil along the length of the building. PCV gutters and downpipes were fitted later in the year using some of the money saved earlier.

E3 The Lighting

E3.1 The Theory

In temperate climates most plants are seasonal. Their growth rates and development are controlled by hormones and the three most powerful environmental factors that hormones react to are day-length, and soil and air temperatures. These hormones normally result in plant species in a given location all behaving the same way; so for instance annual wild grasses all germinate, grow, flower and seed at roughly the same time, as do perennial plants like oak trees and wild iris. In most cases plants are dormant in the winter and grow, flower and seed during the summer, but this is not always true.

It is possible to intervene in this process by artificially cross-breeding identified individual plants with slightly different behaviours (caused by natural genetic mutations) and then by repeating the breeding process over several generations, varieties which behave differently are developed. In horticulture this development of new cultivars with different characteristics is an extremely important tool and allows for instance roses with different coloured flowers to be bred and vegetables of the same type to be produced for longer periods. Thus we know that if we go shopping at just about any time of year we will be able to buy a fresh cauliflower, and most of these will have been grown in the UK (or a near European neighbour). The chart overleaf³ in e16 shows how an original crop with a very short season has been cross bred to allow cauliflowers to be grown all year round.

³ Thanks to Moles Seeds for this.

Variety	Sowing					Harvest						
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NAUTILUS F1 VCA488												
AVIRON F1 VCA500												
ALL YEAR ROUND VCA430												
SNOWBALL VCA540 & VOG200												
GRAFFITI F1 VCA475												
IGLOO VCA695												
FREEDOM F1 VCA435												
CELIO F1 VCA502												
CLAPTON F1 VCA550												
AMAZING VCA462 <i>New</i>												
SEOUL F1 VCA470 <i>New</i>												
CORNELL VCA445												
CASSIUS F1 VOG195												
SUNSET F1 VCA485												
TREVI F1 VCA508												
NAVONA F1 VCA515												
VERONICA F1 VOG202												
MINARET VCA720												
RAFALE F1 VCA480												
AUTUMN GIANT VCA450												
LAZIO F1 VCA520 <i>New</i>												
BELOT F1 VCA460 & VOG198												
OPTIMIST F1 VCA493												
DEAKIN F1 VCA455												
TRIUMPHANT F1 VCA545												
NORTH FORELAND F1 VCA705												
MEDAILLON F1 VOG207												
REDOUBTABLE F1 VCA507												
MASCARET F1 VCA680												
LUNDY F1 VCA710												
AALSMEER VCA670												
CHESTER VOG208												
CELEBRITY VCA700 & VOG205												
MAYFLOWER F1 VCA492												
LONGSHIPS F1 VCA715												
EVITA VCA660												
PERON VCA685												

Please note that the information given in this chart is for reference purposes only. *This variety should be sown/interplanted under glass in months and transplanted in spring

e16 Cauliflower successional sowing and cropping chart

The green bars show the harvest times and these span a full 12 months. (It is interesting to note that despite this year-long harvest, sowing times are limited to only 6 months.) Other crops cross-bred to permit a 12 month growing season include carrots, lettuces and cabbages.

The other way this limited seasonality of particular crops can be changed is by making plants believe that it is their proper growing season by raising them in artificial conditions. In parts of England, (and especially in Holland), there are acres of glasshouses where salads and other crops are raised with heating and lighting to replicate summer conditions. These are often located in areas with high levels of sunshine such as south-west Sussex (see e17 overleaf).

In these highly sophisticated growing environments, the growing season is not only extended by a few weeks, as it would be in a normal garden greenhouse, but made 365 days long.



e17 Google image of salad and tomato greenhouses in Sussex

However this costs money, particularly in terms of energy use, and as large amounts of gas and electricity are consumed, plenty of CO₂ emissions are created too.

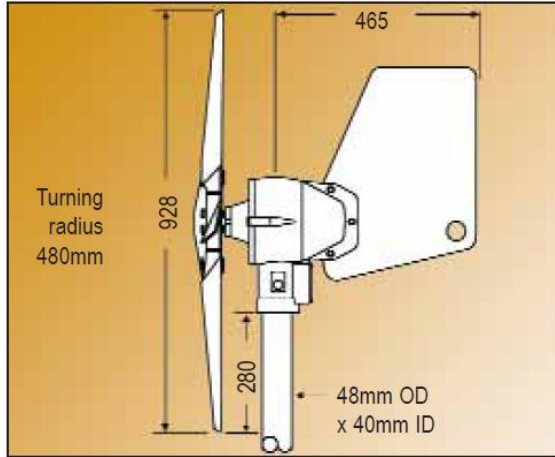
With these facts to hand Sustainable Uist wanted to see if the very short growing season on Uist could be extended, but without producing the related CO₂ emissions. The idea was founded on using a wind turbine to produce the CO₂-free energy – making the most of a natural energy resource in plentiful supply in the Hebrides. However this choice does limit the amount of power available because the turbine could not be relied upon to produce a constant flow of electricity. As a result, any form of direct heating to raise temperatures was discounted, though it was assumed that conditions inside the greenhouse would be warmer than outside by a degree or two.

This left the possibility of just extending the day-length using artificial lighting. The limited budget would limit the scale, but there should be sufficient energy to light a reasonable area by up to an additional 10 hours per day. This would not set out to match the sun's radiation energy, but see if any crops could be persuaded to keep growing by stimulating light receptors and making plants believe it was the growing season.

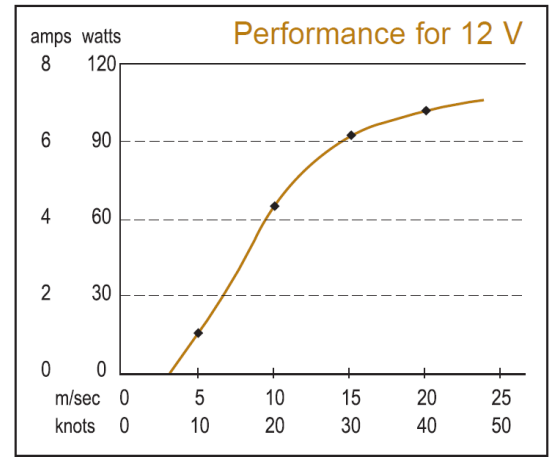
E3.2 The Turbine (2010-11)

The choice of turbine type and output was determined by the budget of £5,000 for the complete turbine, battery, control and lighting installation, and the local environmental conditions characterised by regular gales and salt spray. It was also decided to use a 12V system to minimise any safety concerns.

A marine turbine as used on ocean going yachts seemed the best option and the UK leaders in this field are Ampair. Of their models both the 100W and 300W would have been suitable, but the budget dictated that the smaller model be used. The design and output curve are shown below.



e18 Ampair 100 dimensions



e19 Performance curve

This was erected on a 6m high mast supported by 4 stainless steel cable guys.



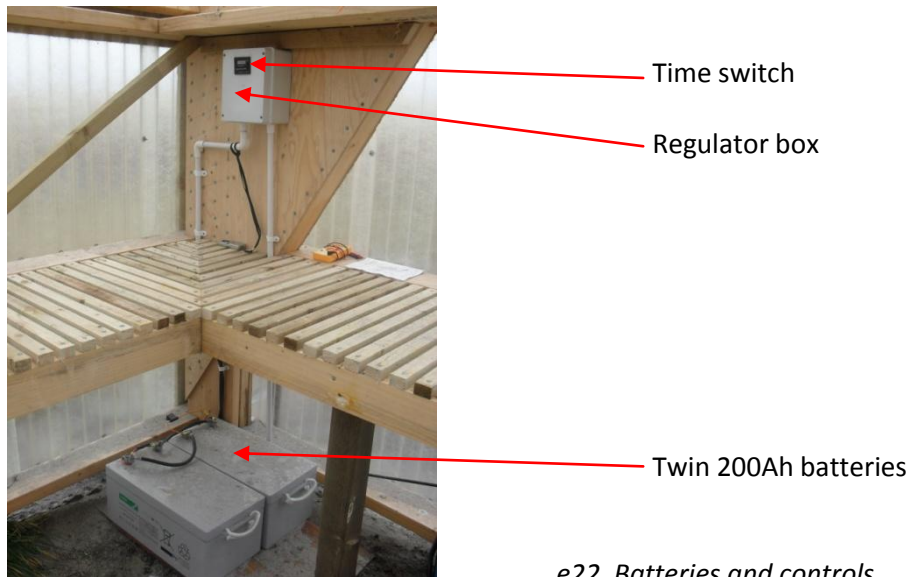
e20 Installation in progress



e21 and complete

E3.3 The Supply and Controls

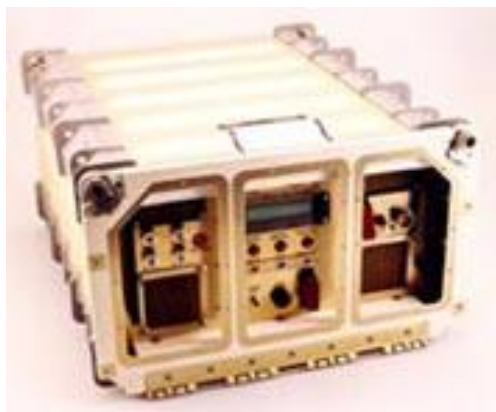
The 12V DC output is taken through a regulator to a simple two wire battery connection. Two 200Ah heavy duty 12V batteries are used for storage and a small time clock controls the power to the lighting system. These were installed in a corner of the greenhouse.



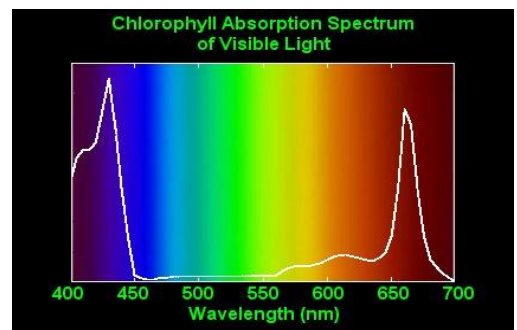
e22 Batteries and controls

E3.4 The Lighting

The original intention was to use white LED bulkhead lights – LEDs give the best light for the lowest possible energy input as they create little or no heat. However 12V units of any size were difficult to find. Some further research revealed that plants only really respond to red and blue light so the energy used to produce the other colours (such as green which is reflected away as the green colour of most plants) is effectively wasted.

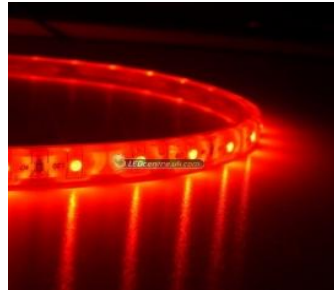
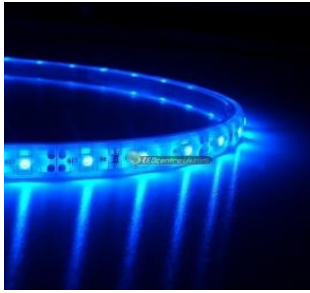


e23 NASA Astroculture Research Unit



e24 Chlorophyll absorption spectra

NASA carried out some research in the 1990s looking at how plants responded to light in the very controlled conditions of a Space Shuttle mission and found that plants would grow well under just red and blue LED lighting because they were the two main wavelengths absorbed by chlorophyll. They also discovered that the relative colour proportions that worked best were around 80% red and 20% blue.



e25 12V LED strip

lighting 4.8W/linear metre

Fortunately red and blue 12V flexible LED strip lighting is made for external use and it is possible to buy this by the metre length. For the experiment, 15m of red and 5m of blue were used creating a demand of just under 100W. By restricting lighting to these two colours all the wasted energy used to produce the other colours in white light is saved.

The lighting was fixed to a timber frame and held in position about 50cm above the growing area by 4 suspension cords.



e26 Lighting rig



e27 Fixing detail



e28 Lighting rig in position



e29 Lighting on, showing red/green distribution

Turbines on Uist are expected to operate at around 40% efficiency, so over a typical period around 1200W/day should be available for the lighting. With a power demand of around 100W it was therefore expected there would be sufficient capacity for up to 12 hours of operation per day. Battery capacity was monitored daily using a voltmeter.



e30 LED lighting at night



e31 The greenhouse at night

E4 The Crop Trials (2010-11)

E4.1 The Theory

The premise of the experiment is this:

That by extending the length of the day, crops will be tricked into thinking it is the growing season. This will encourage them to keep growing when they would otherwise be dormant. This should lead to increased outputs.

It was not known which if any crops would respond to the extra light. It was known that winter varieties of crops like land cress, lamb's lettuce, cauliflower, lettuce, beetroot, salad onions all grow satisfactorily while days are short. They are hardy and seem unaffected by the reduced daylight and cool temperatures apart from a slowing of growth. In most cases the crops become dormant for a few weeks around the shortest day and then growth accelerates as the days get noticeably longer.

There is another set of crops called oriental greens which are true winter (short day) crops. These include mizuna, Chinese cabbage, pak choi, mibuna, tatsoi and radish. These are all brassicas.

In order that the widest range of plant families could be tested, it was decided to trial 25 different varieties of 10 different plant families. These are listed in the table below. Those marked in yellow were sown direct, the remainder raised as plants.

1	BEETROOT Detroit 2 Bolivar	14	LETTUCE All the year round
2	CARROT Amsterdam Forcing D	15	LETTUCE Roxy
3	CARROT Nantes Frubund D	16	LETTUCE Lattughino
4	CAULIFLOWER Medaillon F1	17	LETTUCE Romaine
5	CHICORY Sugar Loaf	18	LETTUCE Winter Crop
6	CHINESE CABBAGE Green Rocket F1	19	LETTUCE Winter Density
7	CLAYTONIA Winter Purslane D	20	LETTUCE Little Gem
8	CORN SALAD Vit	21	PAK CHOI Canton Dwarf
9	CRESS Winter D	22	PEA Kelvedon Wonder
10	ENDIVE Cornet de Bordeaux	23	RADISH Rudolph D
11	FRENCH BEAN Speedy	24	SALAD ONION White Lisbon (Winter Hardy)
12	JAPANESE GREENS Mizuna D	25	SPINACH Giant Winter D
13	LEAF BEET Perpetual Spinach D		

e32 Trial plant list

In situ seeds were to be sown on 1st September. Seeds for modules were to be sown on 21st July and also planted out on 1st September.

E4.2 The Practice

Two identical beds were prepared on either sides of the greenhouse. Their position is shown on the drawing below. The bed dimensions were 2.4m wide and 3.3m deep.



e33 Greenhouse layout for lighting trial

The beds were prepared by digging in a quantity of waste peat to help reduce pH, improve water holding, and improve solar radiation absorption by making the soil darker. In

addition, each bed was given a few handfuls of 7:7:7 Growmore fertiliser and pelleted chicken manure which was dug in at the same time.

All of the plants and seeds were put in on September 1st as planned. A second sowing of radish and mizuna was made on 20th October once the first sowings had been cropped.



e34 Plants going in



e35 Trays of lettuce modules

E 5 The Trials Results

E5.1 The set up

It was decided to start the lighting experiment at the autumnal equinox – 21st September. At that time, the intention was to keep the day length at 12 hours and so over the next three weeks the lighting was turned on for an extra 30 minutes morning and afternoon before and after sunrise and sunset. This was increased to an hour after two weeks, but it was realised soon after that there was no discernable difference in growth rates between crops in the lit and unlit plots with that level of lighting.

It was decided that the best option was to maximise the lighting period to the extent of the power available. It was, therefore, increased to an extra 12 hours per day, coming on at 0300, going off at 0900, on again at 1530, and off at 2130. Within two days this alteration produced a noticeable response.

The crops were laid out in a random order but with a mirrored position so that crop rows in the lit and unlit beds were effectively opposite one another. The layouts are shown below and these are reflected in the record photos that follow.

Spinach	Pea	French B
Pak Choi	Radish	Salad Onion
Lettuce AYR	Lettuce LG	Lettuce Roxy
Winter cress	Carrot Amst	Carrot Nantes
Lettuce Latt	Lettuce Wint Cr	Lettuce Wint Dens
Corn Salad	Mizuna	Claytonia
Chicory	Chinese Rocket	Lett Rom
Endive	Cauliflower	Beetroot

Unlit side

Endive	Cauliflower	Beetroot
Chicory	Chinese Rocket	Lett Rom
Corn Salad	Mizuna	Claytonia
Lettuce Latt	Lettuce Wint Cr	Lettuce Wint Dens
Winter cress	Carrot Amst	Carrot Nantes
Lettuce AYR	Lettuce LG	Lettuce Roxy
Pak Choi	Radish	Salad Onion
Spinach	Pea	French B

Lit side

e36 Lighting trial crop layout

Key indicator crops in terms of visibility were mizuna, lettuce, land cress and cauliflowers

E5.2 Crop Results

The results were monitored by inspection over a 6 month period. A number did not thrive at all. These included peas, French beans, giant winter spinach and a number of the lettuce varieties. Radishes were over in a few weeks.

Results - October



e36 Unlit side



e37 Lit side

Notes for October (see e36 and e37)

- Pak choi went straight to flower – probably because of warm temperatures.
- Mizuna was growing best on the unlit side – probably as this is a short day plant so responds best to non lit conditions.
- Lettuce on the other hand (next to mizuna) were doing significantly better under the lighting.
- Land cress seemed to be even
- Endive (far right and far left)were doing better under the lighting.

Results - mid November



e38 Unlit side



e39 Lit side

Notes for November (see e38 and e39)

- Mizuna was still growing best on the unlit side.
- Lettuce had been cropped on the lit side with a few good sized Winter Crop left just to the right of the mizuna. In the unlit side the small lettuces can be seen to the left of the mizuna.
- Land cress (centre front both) seemed to be doing better unlit.
- Endive (far right and far left) were doing better under the lighting.
- Cauliflower (out of picture) was doing better under the lighting.

Results - early January

Crop	Crop OK	Best	Crop	Crop OK	Best
CARROT Amsterdam Forcing	Yes	Lit	CARROT Nantes Frubund	Yes	Equal
CAULIFLOWER Medaillon F1	Yes	Lit	CHICORY Sugar Loaf	Yes	Equal
ENDIVE Cornet de Bordeaux	Yes	Lit	CLAYTONIA Winter Purslane	Yes	Equal
LETTUCE Roxy	Yes	Lit	FRENCH BEAN Speedy	Yes	Equal
LETTUCE Lattughino	Yes	Lit	LETTUCE Romaine	Yes	Equal
LETTUCE Winter Crop	Yes	Lit	PEA Kelvedon Wonder	Yes	Equal
SALAD ONION White Lisbon (Wint H)	Yes	Lit	RADISH Rudolph	Yes	Equal
BETROOT Detroit 2 Bolivar	Yes	Un-lit	LETTUCE All the year round	No	Failed
CHINESE CABBAGE Green Rocket F1	Yes	Un-lit	LETTUCE Little Gem	No	Failed
CORN SALAD Vit	Yes	Un-lit	PAK CHOI Canton Dwarf	No	Failed
CRESS Winter	Yes	Un-lit	SPINACH Giant Winter	No	Failed
JAPANESE GREENS Mizuna	Yes	Un-lit			
LETTUCE Winter Density	Yes	Un-lit			

e40 Table recording the performance of each crop and whether or not the lighting had affected its performance.

Results – early March



e41 Unlit side



e42 Lit side

Notes for March (see e41 and e42)

By this time the new season had overtaken the effect of the lighting so the experiment was stopped. In the background the tall plants are winter cauliflower (Medaillon) which did very well and produced perfect heads around the end of March, with those under lighting a few days ahead of those unlit.



e47 Cauliflower head



e48 Cauliflower heads

E5.3 Results summary

Looking at the results summary table for January it is clear that the crops tested fall into four main categories:

- Those which did not work at all in any conditions. These include some lettuces, the pak choi and the spinach.
- Those that were not really advanced by the lighting at all, but as normal overwintering crop varieties just matured in the early spring. This included the cauliflowers, salad onions and beetroot, which although they were brought forward a little, did not benefit from the lighting in any significant way.
- Those true winter crops which actually prefer short day conditions and did better without lighting. These included mizuna, some of the winter lettuces and oriental

brassica greens. The mizuna was a striking demonstration of this, being around 50% bigger on the unlit side.

- Those crops which responded positively and noticeably to the lighting. These included the lettuce variety Winter Crop and endive.

Thus the conclusion could be drawn that some lettuce did respond very positively. On this basis it was concluded that with the right varieties, two complete crops of lettuce could be grown between September and April rather than the normal one.

On this basis it was decided to repeat the experiment the following season, but expand it to a full semi-commercial trial.

E6 Second Year Trial – 2011-12

E6.1 Trial Design

The work was to be repeated using the whole greenhouse with lettuce only. One half would be lit, the other wouldn't - there would be 5 beds with lighting and 5 without.

Lettuce varieties would be chosen using advice from a commercial seed merchant. Plants would be raised in batches of around 120 in steady succession allowing planting out to take place from 1st September and then fortnightly at regular intervals through to the early New Year.

As crops ripened they would be harvested and the ground replanted. It was thought that with 12 bays of 120 plants it should be possible to get 2 crops from the lit side and one from the unlit side making a total of around 2,000 for the winter period.

We needed to substantially increase the lighting – by 5 fold. However we knew from the work in 2010-11 that because of our high average wind speeds we had too much energy being generated by a 100W unit for a 100W load so were confident we could get the energy we needed from a 300W unit, so decided to install an Ampair 300.

E6.2 The Crops

Advice was taken from commercial organic seed suppliers Moles Seeds on lettuce types. Apart from true winter varieties that might respond to lighting we also wanted ones resistant to *pythium* or damping off which had affected some lettuces the previous year. They selected:



Maserati



Brian



Veredes



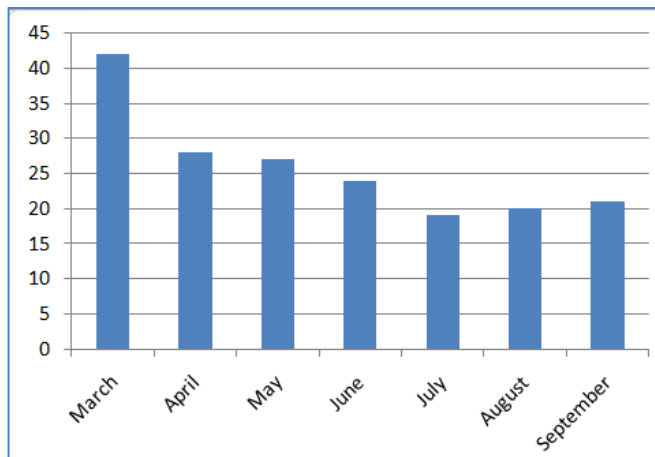
Charita



e45 Trial lettuce varieties
Diana

It was decided to use pelleted seed to help germination rates and reduce seed borne disease risk. Plants were to be raised in 8 x 5 module trays with each batch comprising 3 trays containing 20-25 of each lettuce variety.

Sowing timing had to be researched as it was known that later in the season plants would take longer to reach planting out size. From earlier work it was known that timings between sowings and planting out dates for early season lettuce worked as follows:



e46 Graph showing number of days (y axis) taken for lettuce seeds to reach planting out size in different months of the year.

It was also known that unless greenhouse crops were planted before early September they would not be ready in time to get a second crop in, so the first main batch of plants would be required by that date. From the above graph it was calculated that:

- For plants to be ready by 29th July we need to sow 3 weeks before = 8th July
- For plants to be ready by 4th September we need to sow just under 4 weeks before = 9th August

It was decided to do sowings twice per week as follows:

Batch	Sowing Date	Planting Date	Plant Numbers	Plant out
1	8 th July	29 th July	120	100
2	12 th	2 nd August	120	100
3	15 th	6 th	120	100
4	19 th	10 th	120	100
5	22 nd	14 th	120	100
6	26 th	18 th	120	100
7	29 th	22 nd	120	100
8	2 nd August	27 th	120	100
9	5 th	30 th	120	100
10	9 th	4 th September	120	100
		TOTALS	1,200	1,000

e47 Table of lettuce sowing and planting dates

All these plants were to be harvested steadily from September to mid January. The plan then would then be to replant bays as they became free with the second batch of plants.

It becomes very difficult raising plants to maturity after mid August sowings, so the aim was to have all plants raised by the end of September. Thus the plant raising timetable for the second 1,000 had to be more compressed.

Batch	Sowing Date	Planting Date	Plant Numbers	Plant out
1	12 th August	lateSeptember	300	250
2	16 th	October	300	250
3	19 th	November	300	250
4	23 rd	Dec-Jan	300	250
TOTALS			1,200	1,000

e48 Table of lettuce sowing and planting dates – second phase

A further difficulty is holding these plants in a good condition until the planting out times – up to 4 months.

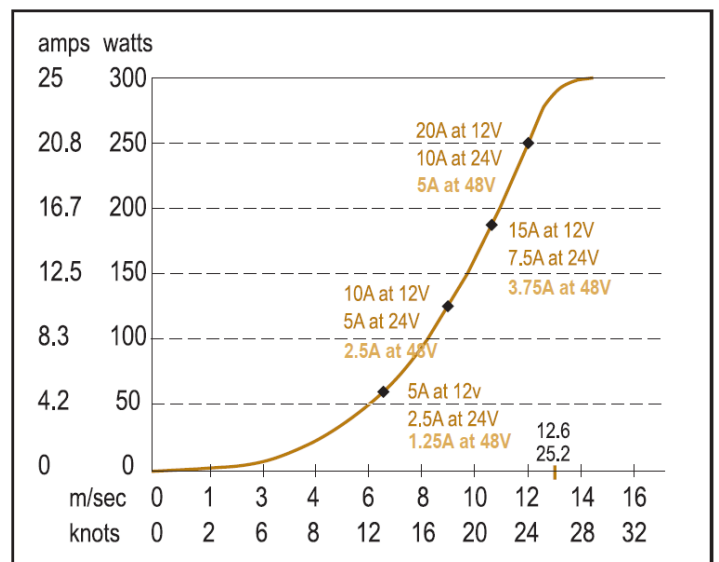
It was known disease would be an issue, particularly damping off. We chose resistant varieties, but also decided to disinfect the soil surface with Milton fluid before planting out which we had heard helped control the problem.

E6.3 The lighting – 2011-12 project

A new Ampair 300 unit was fitted to the existing mast. This was funded by Community Energy Scotland.



e49 Ampair 300



e50 Ampair 300 performance curve



e51 New lighting at night

With this came new control gear which had to be fitted and we also installed two new heavy duty 200A batteries to supplement the existing ones. Lighting was fitted to bay width frames as before and set up down one side of the greenhouse. The total loading was just under 100W for each of the 5 rigs.

E7 The Results

The plant raising and planting regime went well and by the last week of September the whole greenhouse was planted up. By this time the first lettuces in beds 1 and 2 were also ready for cutting, although the lighting was not switched on until the equinox on September 21st.



e52 Greenhouse 23rd Augus



e53 Greenhouse 25th September



e54 Bed no 1 13th September



e55 Bed no 2 13th September

Soon after this date, the lettuces from the first two beds were cut and the beds replanted



e56 Replanted bed 1 12th October



e57 Replanting bed 2 12th October



e58 Open Day 22nd Octobe



e59 Aphids on lettuce

The crops provoked significant interest on the Open Day held on 22nd October and were featured in an article in the local community newspaper in November. However at the same time aphid numbers seemed to be getting out of control in the mild wet weather that persisted day after day right through the autumn. There is no treatment currently available for this pest and the normal decline in aphid activity that takes place as temperatures drop just did not happen.

Despite this problem, by the first week of November real differences in crop size between the lit and unlit sides were noted. In beds 9 and 10 which were planted only around a week apart these showed quite clearly. As with the 2010-11 trial it was the Winter Crop type lettuce Veredes that did particularly well, although increases in size were noted in all lettuce varieties. At the same time it was evident that the aphids were rapidly increasing in number.



e60 Bed 10 unlit 12th Novembe



e61 Bed 9 lit 12th November

We had suffered some lettuce plant losses in 2010-11 and this was put down to ‘damping off’ a general set of fungal diseases which cause young plants especially to wither and die. It was believed our version was probably *pythium* a type of soil borne fungus which attacks root systems, particularly in cold, wet soils.

In 2011-12 some losses were noted in plant trays quite early on but plants seemed able to revive once planted out. However the varieties Brian and Charita seemed particularly susceptible and mature plant losses in these crops seemed high right from the start.

As the aphid persisted right through November a sudden change in the extent of *pythium* affected plants was noted around the 12th of the month. It is thought likely that the aphids had become a vector for the disease, transferring it from plant to plant.



e62 Bed 1 - 12th November



e63 Bed 1 - 1st December

(compare these with 12th October photo e56)

This accelerated rapidly over the next two weeks as the rain persisted day after day and the ground around the greenhouse became flooded, and the soil inside completely waterlogged. By the end of the month nearly every lettuce was dead and the experiment had to come to an end.

The results achieved are recorded in tables e64 and e65 below.

Batch	Sowing Date	Planting Date	Harvest	Harvest Dates	Harvest Comments
1	8th July	4th August	108	23/9 (OK)	Losses mainly in Brian
2	12th	10th August	113	12/10 (OK)	Losses mainly Brian
3	15th	10th August	99	21/10 (too late bad greenfly)	Losses in Charita and Brian
4	19th	19th August	81	21/10 (just OK)	Losses in Charita and Brian
5	22nd	23rd August	77	from 22/10	Losses mainly in Charita
6	26th	23rd August	90	from 22/10	Losses mainly in Charita
7	29th	2nd Sept	0	N/A	All lost
8	2nd August	13th Sept	0	N/A	All lost
9	5th	15th Sept	0	N/A	All lost
10	9th	23rd Sept	0	N/A	2 re-emerged in March
TOTALS			568		

e64 Results of first plantings – started 4th August

Batch	Sowing Date	Planting Date	Location	Harvest Dates	Harvest Comments
	12 th August	8th Oct	Bed 1	N/A	All lost
	16 th	12/13 Oct	Bed 2	N/A	7 re-emerged in March
	23 rd	21st Oct	Beds 3/4	N/A	Plants are iffy
	5th Sept	N/A	N/A	N/A	
	15th Sept	N/A	N/A	N/A	
	8th Oct	N/A	N/A	N/A	
	31st Oct	N/A	N/A	N/A	
	12th Nov	N/A	N/A	N/A	
	1st Decem	N/A	N/A	N/A	
TOTALS			0		

e65 Results of second plantings started 8th October

Clearly this turn of events was unexpected. However the question is - was it predictable? Let us review the combined likely causes one by one:

Aphids – we had no aphids at all in 2010-11 so they could not have been predicted. It is not clear where they came from, but it is most likely to have been on bought in tomato, pepper and other plants used in the neighbouring community greenhouse.

Weather – the autumn weather in 2011 was exceptional and this followed a very wet summer. There wasn't a single day between the end of September and mid December when it didn't rain at some point during the day and temperatures were incredibly mild. A good part of the west coast machair ended up under water and these conditions were completely unsuited to growing lettuce – even inside.

Pythium – this probably came from one of the greenhouses used to raise plants in the 2010-11 trial. Although the soil in the greenhouse had been used for a few lettuces the season before, the situation was more likely to have been exacerbated by the disease persisting in plant module trays, some of which were re-used and not disinfected first.

Treatment – greenfly always used to be treated with 'Derris' an effective plant derived insecticide, but this was banned in 2009 and no effective direct treatments remain. As *pythium* is soil borne there is no treatment for this either, apart from husbandry techniques. These would include tray and soil disinfection as described above, proper rotation practice and resistant variety selection. The latter point is proven by the re-growth in a few Veredes plants which re-appeared in late February and seemed to be developing well.



e64 and e65 Re-emerging Veredes lettuce in beds 2 and 10 in late February 2012

By the third week of March these had developed well and were ready for cutting and had a surprisingly good flavour. These were a true, second winter lettuce crop.

E8 Project Review

Trials: The trials worked well initially, but eventually failed due to a combination of exceptional weather and unforeseeable pest and disease problems.

Community: The community did show interest in the project though one member of the community criticised it as a waste of resources⁴. Because of the significant cost of building greenhouses and installing lighting, it was never the intention to promote large scale protected cropping to gardeners. However, at least two greenhouses of this design have now been built on Uist contributing in a small way to the long term improvements in local food sustainability, and a number of other people have requested copies of the drawings.

CO₂ emission reductions: The reductions to be delivered by the trial itself were delivered to the extent of 600/2000 lettuces i.e. 30% of those targeted. However, underlying the whole project was the Sustainable Uist premise being tested, which was this:

It is understood that significant CO₂ emission savings are made by growing food locally both outside and in, which results in significant reductions in food miles. However, could significant extra CO₂ emissions be saved in a protected cropping facility with renewable energy powered lighting as an add-on facility which would allow some high embodied CO₂ winter crops to be grown all year?

To answer this, the following questions need to be answered:

1. how much CO₂ was used to develop the facility?
2. what was its likely life span?
3. what crops could be grown within it during that lifetime and what CO₂ would they save?

Calculating embodied CO₂ in building construction is not easy. However, from the paper by Peter Elbourne on greenhouse gas emissions and polytunnels⁵ we know that a typical polytunnel has an embodied CO₂ figure of around 14kg/m² of area, and we feel that we can make the same assumption too, especially as our greenhouse has a home grown timber rather than metal structure, though it has a higher weight of plastics involved. So for a 100m² greenhouse we presume embodied carbon of 1,400kg.

The wind turbine weighs around 20kg and if we presume it is all aluminium at 10kg CO₂/kg it has embodied CO₂ of 200kg. The lighting and cables are unknown, but may amount to say 100kg.

Using the figures from the same paper for CO₂ savings from production of summer crops these give savings of 17.5kgCO₂/m²/year (likely to be higher for Uist because of extra food miles) and we have already estimated further savings of 0.2kg/lettuce over the winter months on a potential of 2,000. This gives potential annual CO₂ savings of 2,150kg/year.

The likely life span of the greenhouse is 25 years. The turbine and lighting is probably half that so over a 25 year lifespan we have embodied CO₂ of:

⁴ See letter to Am Paipear December 2011.

⁵ Reducing Food-Related Greenhouse Gas Emissions Through Local Production Of Fruit And Vegetables, Peter Elbourne 2009

$1,400\text{kg} + 2 \times 300\text{kg} = 2.0 \text{ tonnes}$

If the greenhouse was used consistently over its 25 year life it would deliver

$25 \times 2,150\text{kg} = 54 \text{ tonnes CO}_2$

So compared to the embodied CO₂ of 2 tonnes the whole project is very worthwhile even if it is only used half the time.

As regards the turbine and lighting and the extra lettuces these can deliver, over the 25 year lifetime we have embodied CO₂ of say 600kg versus an extra 600 winter lettuce per year at 0.2kg⁶ per lettuce, so again this is easily 'paid off' in the first 5 years.

Thus the question that was raised by a member of the public in the local paper as to the point of this particular trial, and whether a better use of resources might have been to persuade people to stop eating salad out of its main season, the answer might be given:

Although there is embodied CO₂ in the greenhouse and turbine and lighting, the potential savings in CO₂ emissions from growing local food throughout the year rather than importing it from warmer climes are just about all offset in the first year of use, so these resources are being put to good use.

E9 Project Conclusions

The trials established that it is possible to grow winter salads successfully within a locally designed and built greenhouse and that additional lighting can produce extra outputs.

The potential lifetime CO₂ emission savings from building this kind of facility far outweigh the embodied CO₂ in their construction.

Mono-cropping in horticulture has inherent risks from a pest and diseases perspective so care has to be taken with crop selection and pest and disease control to make sure that excessive losses don't occur.

Sustainable Uist is reviewing the possibilities of setting up a winter salads growing facility as part of a medium scale vegetable and salad production unit based on some form of Community Enterprise.

⁶ It is believed this original figure is too low as it only accounts for the CO₂ savings in food miles for transport from S Spain and not the savings in the actual production of the lettuce themselves which amount to an additional 0.1kg/lettuce. This would reduce the CO₂ payback time to around 3.5 years.

Section F: Peatland Vegetable Growing Trial

F1 Project Background

The contrasting characteristics of the soils on the east and west sides of Uist could not be greater, despite the fact that in places they are separated by less than a few 10s of metres:

Location/type	pH	Organic matter %	Drainage	P ADAS index	K ADAS Index	Mg ADAS Index
Peat soils	4.5	66.6	Very poor	1	1	8
Machair soils	8	3.3	Free	4	0	7

f1 Soil properties for peat and machair soils on Uist

Whilst two of the three main inhibitors to successful vegetable growing in Uist were common to both soil types – high winds and short season - these differences in soil character meant that the recommendations arising from the results of the trials on the machair at Liniclate would be very different to those for growers away from the western fringes of the islands.

After some lobbying from members of the public, Sustainable Uist sought and received funding from the CCF to repeat the 2010-11 machair based trials in a location with peat based soils.

F2 Project Design

It was realised from the start that it would not be necessary to fully repeat the extensive 2010-11 machair trials, but that the work could be limited to testing of cultivation techniques and varieties only. Thus the same group of best performing crops identified for the year 2 trial at Liniclate could be used in a wind protected environment with suitable nutritional applications.

The requirement was, therefore, for around 100m² of reasonable ground in a peat soil location. In addition, we had been requested by CCF to try and avoid using a previously uncultivated site for both environmental and CO₂ emission reasons.

The owners of croft no 2 Gearradubh, Grimsay Island - Lachlan Theona and Padruig Morrison - had been members of Sustainable Uist from its inception and offered the use of an area of their ground for the work. A one year lease was signed in May 2011 and work started on site soon after.



f2 Croft no 2 Gearradubh on Grimsay with the site shown in green

As can be seen from the satellite photo, this area of Grimsay has been crofted for an extended period with signs of old walls, buildings and lazy beds evident. The site chosen was reported to have been used for cropping within living memory, but not recently.

F3 Project Set Up

3.1 Cultivation

As the area of ground was small it was decided to cultivate it before fencing. The favoured option was ploughing, but it proved difficult to find anyone willing to do the work. Apart from being a busy time of year there is natural caution when ploughing uncultivated ground because of the risk of damage to plough coulter, shares and mould boards from hidden rocks. Eventually, and running short of time, we accepted an offer of rotovation. This proved later to be a poor decision.

3.2 Protection

It was decided to wind fence the whole area and this was done using a standard stock proof fence with locally sourced builders' safety netting attached for wind protection. Enviromesh covers were then arranged for a series of 6 beds in which to grow crops.

3.3 Nutrition

A soil sample had been taken from another typical croft on Grimsay in 2010 and from these results (see table at f1 above) it was decided that as the ground had been grazed for a substantial period the only real need was for phosphate fertiliser. For this we used Laws Organic High (15%) P, with a recommended application rate of 500kg/Ha. Thereafter crops would be monitored for any deficiencies as they developed, and if necessary treated with a liquid feed.

3.4 Drainage

It was already understood that drainage is the key to successful growing on peat land. Peat is highly hygroscopic, to such an extent that it will draw in water through capillary action from adjoining water courses or standing water. When the strainer post holes were being dug, ground water was discovered in the NE corner and this started to overflow onto the cultivated land. To dispose of this a drainage channel was dug down the NW and SW plot edges and this was eventually extended along the upper NE edge. All of this work took place towards the end of May in reasonable weather, but soon after, a prolonged wet period commenced which is highly unusual on Uist at this time of year. The whole plot and the surrounding area became saturated.



f3 Drainage channel



f4 View of finished plot from NW



f5 from higher ground to SE

This led to a serious combination of problems – a shallow layer of some 15-20cm of saturated rotovated soil lying over an equally wet, hard peat layer. It became impossible to even walk on the ground let alone weed it, or plant it up, or sow seeds. In addition the plot became swamped with weeds from dormant seeds brought up by the rotovator.



f6 First brassica



f7 Weeds

Some early brassicas plants were tried in a slightly higher area at the SE end of the plot, but they could not grow in the difficult conditions.

3.5 A change of strategy

As the wet weather continued without pause into July it was decided to change cropping strategy. Traditionally land like this would have been cultivated using a lazy bed system. These are formed by digging parallel ditches around 30cm deep at roughly 180 - 240cm centres down the slope, and turning the excavated soil/peat onto the ground between. This results in a series of beds around 120 - 180cm wide and raised up around 40cm above intermediate drainage channels. Two of these were dug by hand in late July and early August and the peat soil broken down. This dried out quite quickly (even as the rain continued) and the prepared soil was then treated with the High P fertiliser before being planted up. The drainage channels were eventually connected into a new land drain and the excess water taken right away from the site.



f8 Lazy beds

3.6 Crops

Whilst the conditions were not good for sowing seeds, back at Liniolate a complete set of brassica, salad onion, beetroot and pea plants was being held in trays and these were planted out in the beds as soon as possible in early August.

3.7 Results

In the warm damp conditions, in what in many ways could be described as an ideal growing medium, all the plants thrived. This was despite the lateness of the

season. By the middle of October some plants had reached cropping stage and we had good calabrese, cabbage and peas, and beetroot were looking strong with excellent leaf development and colour, though bulb size was small.

Weeds were rife and were a completely different set to those on the machair – much more akin to normal cultivated land including buttercup and redshank – but most of the crops out-competed them easily.

(All the pictures below were taken on 17th October 2011.)



f9 Peas and asparagus peas



f10 Peas (note redshank and buttercup)



f11 Brassica bed



f12 Calabrese head



f13 Savoy cabbages



f14 Beetroot

Although the project monitoring finished in December, the croft owners reported good cabbage, purple sprouting and cauliflower going right on into February.

4 Project Review

Trials: Despite the difficulties encountered with the drainage and exceptionally wet summer the crop results gained from this experiment far exceeded expectations. Because these results are so good it is possible to make some reasonable predictions as to what would happen in a normal growing season (given the right growing conditions) and from these, some recommendations as to how to grow vegetables in Uist peat soils can be made.

Drainage is key to everything. If this isn't right then it is not even possible to walk on the land let alone use it for any productive purpose. Even if the land appears well drained, it may well not be in a wet season, so proper drainage should be installed.

Cultivation has to be by hand or using small scale machinery, and, as demonstrated, has to maintain or create very good drainage at the same time.

Peat soils have a much better base fertility than those on the machair. Phosphate levels are an issue, but can be dealt with (at present). Despite the very low pH of peat soils, vegetable crops in general prefer slightly acidic rather than alkaline growing conditions.

Crops: A wide range of **crops** can be grown. Conditions would appear to favour the growing of planted rather than directly seeded crops, although it is likely that if the right tilth could be developed, these would do well too.

Protection from wind and pests using wind fences and crop covers is also required, although the exposure conditions found at the trials site on Grimsay are less extreme than on the machair on the western edge of Uist.

Weeds are an issue, and will require extra effort to keep them under control.

Community: Because of the difficulties with the early stages of the trial and the lack of verifiable results there has been no communication with the community on this project apart from through this report.

CO₂ emission reductions: The final question is this:

Can vegetable growing on Uist peat soils contribute to long term reductions in imported food volumes and the associated food miles and CO₂ emissions?

Cropped peatland in temperate climates is estimated to give off excess CO₂ during its use of around 10 tonnes CO₂/year⁷ which is the equivalent of 1kg/m².⁸

We know from Peter Elbourne's paper⁹ that outside cropping of vegetables saves around 1.5 kg CO₂/m²/year.

To this we can add in the extra food miles CO₂ for the remote island location. We have estimated these at 0.05kg CO₂/kg weight produced so with an average cropping rate of 3kg/m² this is likely to add another 0.15kg/m², making a total of 1.65 kg CO₂/m²/year.

Thus we can safely say that more CO₂ will be saved by growing vegetables on Uist peat soils than by importing them.

5 Project Conclusions

The trials demonstrated that there is significant potential to grow food crops successfully on peat soils.

There are CO₂ emission issues with peat soils which have to be considered carefully and un-necessary tillage of soils which are not put into production should be avoided.

The great advantage of the machair soils is the possibility that they can be worked mechanically and extensively on a large scale – as they are at present on Uist for agricultural arable crops. Thus it seems quite reasonable that in the medium term, the islands could become completely self-sufficient in a number of vegetable staples such as roots, brassicas and alliums by growing these crops on machair soils. However, because of the access and drainage issues this isn't going to be possible in the same way on the peat soils. However, at a smaller scale these areas will be able to make a valuable contribution, and in many ways, once growing areas are properly set up, crop results for home gardeners and smaller growers should be of better quality than on the machair.

⁷ Greenhouse gas emissions from managed peat soils: J. Couwenberg 2011

⁸ This is thought to be around twice the level of low organic matter soils.

⁹ Reducing Food-Related Greenhouse Gas Emissions Through Local Production Of Fruit And Vegetables, Peter Elbourne 2009

Section G: Community Greenhouse

G1 Project Background

Despite plenty of interest being shown by community members in the Liniclate vegetable growing project in the first year, it was evident by the end of 2010 that not many had decided to actively take up growing their own produce as a result. This reaction seemed to run counter to reports from other CCF groups on the mainland where waiting lists for allotments, especially in urban areas, were the norm.

Sustainable Uist did look briefly at the possibility of setting up allotments in the three main settlements on Uist (Lochmaddy, Balivanich and Lochboisdale) and had started discussions with the relevant landowners, but had been dissuaded by two main issues:

1. The extremely cautious position adopted by landowners who believed that any shared growing facility would be difficult to manage, and
2. The difficulty of finding areas of good growing land of any size in suitable locations, which included the required additional facilities such as access, parking, water supply etc.

In these circumstances, and without any particular pressure from the community, there seemed little point in progressing an allotment initiative any further.

However, in the background there was some evidence that whilst the problems of actually producing reasonable crops on Uist had been sorted out, there was nothing that could be done about the challenging weather conditions which makes any work outside difficult for a good part of the year. In addition a lot of interest had been shown in the self-build greenhouse erected at Liniclate in the summer of 2010 and drawings had been given to a number of local residents. At least two were subsequently built and this seemed to suggest that an ability to grow crops inside might prove more appealing.

As a result, Sustainable Uist decided to seek funding from the Local Authority (CnES) to build a community greenhouse which would be run on allotment lines. The capital funding was awarded in March 2011 and the management of the construction and associated community growing group incorporated into the CCF Local Food Officer role. CCF also contributed £3,000 towards the construction costs and £500 towards equipment and other costs for the project.

G2 The Project

The project proposal was a simple one:

- To build a second greenhouse at the Liniclate trials site identical in design to that erected in 2010;
- Identify members of the community group who wanted to use it;
- Help them get started with their growing;
- Help them become an autonomous group.

G3 The Greenhouse

The greenhouse was built to the same design and in the same way as that for the protected cropping facility. The concept and processes can be read about in section E of this report. It had been hoped to get the greenhouse completed by the end of May, but despite several earlier attempts, it wasn't possible to undertake the main erection process until July 13th because of the high water table. Even then the work was extremely difficult and went on until well after dark.



g1 Panoramic view of site prepared for construction



g2 First frame going up on 13th July at 1930 with some of the community greenhouse group looking on.



g3 Water in post hole



g4 Last frame going in at 2300



g5 28th July – sheeting going on

With the main portal frames in place, the remaining framing, sheeting, doors and finishings were completed over the next few weeks. The total construction costs were £12,435.

(Because of the delay in being able to erect the greenhouse, caused by the very wet weather, the decision had been taken some weeks earlier to allow the Community Greenhouse Group to get started in the existing protected cropping greenhouse and to carry out the winter 2011-12 lettuce trial in the new greenhouse.)

G4 The Community Group

In the December 2010 edition of the Uist community newspaper Am Paipear, the following notice appeared:

Sustainable Uist looks to offer indoor community allotments

Sustainable Uist, the carbon reduction project based at Liniclate, Benbecula, hopes to construct a greenhouse to provide 8 local people with indoor starter allotments in time for the 2011 growing season. The proposed building will be identical to the existing greenhouse and sit alongside it at the field trials site at Liniclate.

Anyone who would like to be kept up to date and be considered as an allotment holder should express their interest by emailing david@sustainableuist.org or phoning 01870 603863.

A total of 8 responses were received and eventually 6 residents from the west side of Benbecula signed up for the project. In May the first meeting was held and cultivation and growing got under way shortly afterwards.

G5 The Project

The greenhouse was divided into 8 bays with each member being allocated one bay. Advice and help was given to develop growing plans and source seeds and plants as necessary. Instruction was given to less experienced growers on the requirements for nutrients, water and weeding and husbandry for each plant type.



g6 The community greenhouse 24th August 2011

A wide variety of crops was tried including tomatoes, cucumbers, peppers, chillies, courgettes, beans, herbs and salads and by August the first crops were being harvested. Cropping continued into the autumn and the greenhouse was eventually cleared in November. One plot holder decided to try some winter brassicas and successfully grew calabrese and purple sprouting for harvesting in the New Year.

G6 Project Review

Greenhouse: There were some delays in erecting the community greenhouse but any difficulties were offset by using the existing building. Despite the difficult ground conditions the effective, robust and DIY friendly design works well.

Community: The community response to the original offer was less enthusiastic than expected, but a core group was established to work during the first year. In January 2012 a meeting of the group was organised to decide how the project should move forward. At this meeting it was agreed to keep the arrangements informal and avoid having meetings unless absolutely necessary. The allotment holders thought that common sense and courtesy were the most important aspects of sharing the space in the greenhouse. The group agreed to keep in regular touch

via email and to update each other on topics such as holidays, watering and pests. A request for a whiteboard for the greenhouse was approved. Finally, one of the allotment holders offered to raise all the required plants from seed and to share them with the rest of the group. At the time of writing this report (March 2012) growing projects for the coming season are already under way.

CO₂ emission reductions: The reductions that can be delivered by greenhouse cropping have been discussed in the protected cropping report. We know that in simple terms if warm climate crops are grown then the embodied CO₂ in the building is easily offset in a single year. In this case the greenhouse wasn't in full production (about 70%), and some temperate crops such as lettuce and courgettes were grown too, but we can be confident that within another year all the embodied CO₂ will have been offset. Over the next 20 or so years of use (whether it be as a community facility or not) tens of tonnes of CO₂ emissions will be saved using this facility.

G7 Project Conclusions

The Sustainable Uist designed greenhouse has proved to be a good design to grow protected crops within.

A solid core community group has been established to run the project and they have every opportunity to make the most of this facility for themselves over the coming years.

Greenhouses have significant potential to reduce CO₂ emissions that arise from importing warm climate food crops. This project should easily covered the CO₂ embodied in its construction within two years.

The project could act as a suitable model for other protected cropping projects on Uist in the future.

Section H: Uist Food Event

H1 Project Background

As part of its Carbon Neutral Uist 20/20 project (which is targeting a carbon neutral group of Hebridean islands by 2030), Sustainable Uist is actively pursuing an increase in the production, processing, storage and retailing of a wide range of local foods. The strategy proposes that by 2030:

At least 50% of all food consumed on Uist will be derived from local sources and grown using organic methods.

This is a challenging target. At present, despite a wide range of primary food products being grown, raised and harvested on the islands, the vast majority of this produce is exported to the mainland.

As a result, a matrix of current local food production, processing and retailing of 10 main foodstuffs on Uist looks like this:

Food	Primary production	First stage processing*	Store	Added value from processing	Local retail	Export
Meat	Yes	Yes	No	V limited	V limited	Yes
Fish	Yes	Yes	Limited	Yes	V limited	Yes
Dairy	No	No	No	No	No	No
Veg	V limited	V limited	No	No	V limited	No
Fruit	No	No	No	No	V limited	No
Cereals	Yes, feed	No	No	No**	No	No
Drinks	No	No	No	No	No	No
Wholefds	No	No	No	No	Imports	No
Oils	No	No	No	No	No	No
Wild food	Yes	Yes	No	No	V limited	Little

* Slaughter, wash, gutting

** There is a local bakery which uses imported grains

h1 Existing state, and future potential of locally produced foods on Uist

This very limited availability has two main results:

1. Probably the lowest per capita availability of local food in rural Britain. and, in consequence
2. One of the highest rates per capita of food miles and food CO₂ emissions in the UK.

Sustainable Uist believes this situation is not only un-necessarily contributing to climate change, but in addition is a waste of local resources, is bad for the local economy, and, in the context of adaptation to the forecast effects of climate change, completely un-sustainable.

Within its Uist Local Food strategy Sustainable Uist has a set of short, medium and long term objectives. These are:

- Short Term: An immediate and continuous raising of public awareness of the significant possibilities relating to local food through practical demonstration, events and training.
- Medium Term: The development of viable business models for the storage, processing and retailing of existing local food production.
- Long Term: An understanding of how local food production will need to work post 2030 if the islands are going to secure their own food supplies in an increasingly difficult world environment.

To understand the community view about the availability of locally produced foods, Sustainable Uist carried out an extensive customer and producer local food survey during the summer and autumn of 2010. This sought to test the viability of an island Farm Shop – a local food retail model which works well in many rural areas of mainland Britain. The customer survey revealed universal interest in buying a wide range of local food with fish and meat being highest on the list.

Concurrent discussions with several island food producers also revealed the significant scale of production of some local food products including meat, fish (particularly salmon) and shellfish and the fact that the great majority of these products are exported off the island, often in an unprocessed form. A number of issues for producers were also revealed including secondary processing of meat (butchery and offal disposal) and all forms of food storage, but especially chiller and freezer space. One company admitted it had no option but to ship all of its primary harvest to Inverness for frozen storage before transporting it all back to the island in the late autumn ready for processing and packing for the Christmas mail order market on the mainland.

This work seemed to identify a real and unfulfilled market opportunity between producers and potential local customers, but it was felt necessary to set up a practical test to see whether the views expressed through the survey were real.

The idea of a Uist Food Event was conceived where producers and customers would be brought together in a single location on a particular day to see what happened. The project was included in the CCF 2011-12 funding bid and was approved.

H2 Project Concept

A project team was assembled comprising

- Joanna Peteranna: Sustainable Uist Project Manager
- Neil Campbell: Benbecula Community Account Manager
- Marion Ferguson: Sustainable Uist Local Food Officer
- Elaine Cleary: North Uist Community Account Manager
- Jackie Warner: Uist Wholefoods Co-operative

Over a period of several weeks an event concept was devised which would have the following features:

- Two centre event over one weekend – one in North and one in South Uist.
- A main core of stalls displaying and selling island produced food.
- Stalls also to be offered to other Hebridean island food producers.
- Demonstrations to be encouraged.
- Cooking demonstrations using local produce would be featured.
- Hot food would be on sale.
- There would be special features and events for young people.

H3 The Producers

Invitations were sent to a wide range of producers and accepted by the following:

- Isle of Mull Cheese Company
- Sustainable Uist Vegetable Trials Project
- Praban na Linne
- Hebridean Brewery Co.
- Hebridean Chocolates
- Neil Campbell (eggs)
- Lawrence Beaton (butchery)
- Angus Campbell (shellfish)
- Hebridean Smokehouse
- George Jackson (fish filleting)
- Kallin Shellfish
- Loch Duart
- Uist Wholefoods Co-op
- Angus Beaton (razor clams)
- Stephen Peteranna (pollock & mackerel)
- MacLean's Bakery
- Bayhead Shop
- Jinny Jackson (preserves & baking)
- Flora MacDonald (oatcakes)

- Jackie Warner (gluten free baking)
- Anneke Kraakman (salads)
- Jane Twelves (vegetables)
- Ann Morton (vegetables & preserves)
- Sheila's Ice Cream
- Margaret Cowie (local food ready meals)
- Hebridean Kitchen (jams, preserves & tablet)

Cooking demonstrations were volunteered by:

- Neil MacDonald Divers
- Dark Island Hotel
- Rhona Anderson
- Orasay Inn
- Temple View Hotel
- Langass Lodge
- Margaret Cowie

H4 The Events

The events were arranged to be held over a single weekend in September 2011 at Lochmaddy in North Uist and Daliburgh in South Uist. Although the event was widely advertised it is always difficult to anticipate in the public response in advance so we were delighted with excellent visitor numbers to both events. Around 500 people came to Lochmaddy on the Saturday and a further 230 to Daliburgh on Sunday, numbers which far exceeded our expectations.

Food demonstrations proved to be very popular with fish filleting taking the top spot and cheese making following close behind. Cooking demonstrations run by chefs from local restaurants were also very popular. The chefs used a variety of local food to produce beautiful dishes which visitors were then able to taste.

Along with demonstrations, there were lots of products to taste and buy and several of the food producers ran out of their products before the end of the second day. Third Sector Hebrides reported sales of their Hebridean Chocolates in excess of £700.

There was huge interest in local meat at the food event, and it may not have been a coincidence that shortly after the event the local bakery installed a small chill cabinet in their shop which has contained a selection of local meat regularly over the last 6 months.



h2 Hebridean Brewery Co stand



h3 Fish filleting demonstration



h4 Cookery demo by Neil MacDonald Divers



h5 Cheese making demo by Isle of Mull Cheese Co

H5 Project Review and Conclusions

As a result of the local food weekend and other research carried out by Sustainable Uist we can conclude that:

- there is plenty of demand for a range of locally produced food from island residents (and probably visitors too)
- a significant amount and wide variety of local food is being produced on the islands.

However, there is also an important missing link – a permanent market place where the two can be brought together.

Given a number of factors:

- the distance/cost involved in travelling from one end of the islands to the other;
- the cost of staffing a stall;
- the practicalities of maintaining cold storage;
- the difficulties of complying with food hygiene regulations in a village hall,

it is unlikely that any new attempt to run this local food market along Farmers' Market lines regularly would be any more successful than it has been previously. They do not appear to be economically viable to the food producers or sufficiently attractive to consumers

Sustainable Uist believes that the best option for increasing the availability of local food in Uist would be the farm shop model. Food producers would have access to a permanent retail outlet for which they need take no direct responsibility, and customers would have access to a wide variety of local food products under one roof with the added certainty of a permanent location and regular opening hours.

Based on the results of the 2010 survey and 2011 Food Event, Sustainable Uist is now reviewing the possibilities of setting up a Uist Farm Shop based on some form of Community Enterprise model.

Section I: Summary Project Conclusions

Section D The Liniclate Crop Trials

- The trials established that it is possible to grow a wide range of vegetable and salad crops on the islands for a good part of the year.
- The potential CO₂ emission savings from developing this local food industry are significant and have a good chance of becoming permanent and therefore structural.
- The community response suggests that despite thinking that growing vegetables and salads at home is a great idea, in practice relatively few people are willing to get actively involved.
- Sustainable Uist is reviewing the possibilities of setting up a medium scale vegetable and salad production unit based on some form of Community Enterprise.

Section E Extended Season Cropping Trials

- The trials established that it is possible to grow winter salads successfully within a locally designed and built greenhouse and that additional lighting can produce extra outputs.
- The potential lifetime CO₂ emission savings from building this kind of facility far outweigh the embodied CO₂ in their construction.
- Mono-cropping in horticulture is risky from a pests and diseases perspective so care has to be taken with crop selection and pest and disease control to make sure that excessive losses do not occur.
- Sustainable Uist is reviewing the possibilities of setting up a winter salads growing facility as part of a medium scale vegetable and salad production unit based on some form of Community Enterprise.

Section F Peatland Vegetable Growing Trial

- The trials demonstrated that there is significant potential to grow food crops successfully on peat soils.

- There are CO₂ emission issues with peat soils which have to be considered carefully and un-necessary tillage of soils which are not put into production should be avoided.
- The great advantage of the machair soils is the possibility that they can be worked mechanically and extensively on a large scale – as they are at present on Uist for agricultural arable crops. Thus it seems quite reasonable that in the medium term, the islands could become completely self-sufficient in a number of vegetable staples such as roots, brassicas and alliums by growing these crops on machair soils. However, because of the access and drainage issues this isn't going to be possible in the same way on the peat soils. However, at a smaller scale these areas will be able to make a valuable contribution, and in many ways, once growing areas are properly set up, crop results for home gardeners and smaller growers should be of better quality than on the machair.

Section G Community Greenhouse

- The Sustainable Uist designed greenhouse has proved to be a good design to grow protected crops within.
- A solid core community group has been established to run the project and they have every opportunity to make the most of this facility for themselves over the coming years.
- Greenhouses have significant potential to reduce CO₂ emissions that arise from importing warm climate food crops. This project should easily covered the CO₂ embodied in its construction within two years.
- The project could act as a suitable model for other protected cropping projects on Uist in the future.

Section H Uist Food Event

- Sustainable Uist believes that the best option for increasing the availability of local food in Uist would be the farm shop model. Food producers would have access to a permanent retail outlet for which they need take no direct responsibility and customers have access to a wide variety of local products under one roof with the added certainty of fixed location and opening hours.
- Sustainable Uist is reviewing the possibilities of setting up a Uist Farm Shop based on some form of Community Enterprise.