Project Title:	The development of a training programme to improve the use of climate control computers by protected crop growers in the UK
Project Number:	PC 183
Project Leader:	Chris W Plackett, FEC Services Ltd
Report:	Final Report, October 2002
Previous Reports:	None
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Location of Project:	FEC Services Ltd, National Agricultural Centre, Stoneleigh, Kenilworth, Warwickshire
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Date Project Commenced:	1 October 2001
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Key Words:	Energy efficiency, energy, climate control systems, greenhouses, training, education

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Practical Section for Growers

1 Commercial benefits of the project

This project has identified and evaluated the requirements for a training programme to improve the use of climate control computer equipment in protected cropping facilities in the UK. The benefits of growers receiving such training relate to reduced energy costs and the potential to improve crop yield and quality by providing an optimised greenhouse environment.

The project has also identified potential sources of financial support for the training. By taking up the recommendations of this report, and securing such funding, the training will be made available to growers in a cost effective way.

2 Background

Recent increases in the cost of energy and the introduction of the Climate Change Levy (CCL) have made the need to reduce energy costs a priority for growers of protected crops. With energy now accounting for up to 40% of the variable costs of production, growers of protected crops are now seeking practical methods of improving energy performance.

Over the next 10 years the protected horticultural industry in the UK will be under the spotlight to demonstrate improvements in energy efficiency. This is because it has committed to a 15% target through a voluntary agreement with the government. This agreement therefore further highlights the need for solutions to be found quickly and adopted by the industry.

It is recognised that the correct use of climate control computers is a good way of improving energy performance (see HDC project PC 172). Good systems give the user the ability to closely control and monitor the internal conditions within the greenhouse and provide optimum conditions for plant growth. To achieve the desired environment, systems control a wide range of equipment including heating plant (e.g. boilers, CHP & heat stores), fans & ventilators, screens and supplementary lighting.

The rapid development of climate control systems has led to a situation where many growers do not fully utilise the equipment that they have installed in their greenhouses. The physics of greenhouse climate control is a complex subject on its own, so when coupled with the need to understand the operation and set up of a computer based controller, many

growers have significant difficulties. This project has therefore carried out research to identify what training growers would like on the subject of climate control computers and how the training may be delivered.

3 Key Findings

The key findings of the study were:

1. Over 60% of nurseries use climate control computers and the sectors that grow 'high energy crops' (such as tomato, cucumber, chrysanthemum etc) almost exclusively use them.
2. A large number of systems have been installed or upgraded over the last 5 years and are therefore equipped with many of the 'state of the art' features.
3. Priva, Van Vliet (Hortimax) & Brinkman currently have a large numbers of systems installed. TomTech are also popular with some of the smaller enterprises.
4. Current skill levels relating to the use of climate computers are varied and on the whole low.
5. Many growers recognise further training as a high priority issue.
6. Skills are available both in the UK and Europe to deliver detailed training packages. An 'off the shelf' package is not immediately available in the UK. On the other hand IPC (based in the Netherlands) could deliver packages with immediate effect that may be tailored to the individual needs of specific growers / industry sub-sectors.
7. It is recommended that training should be delivered on a modular basis. This will allow material to be conveyed in 'bite-sized' pieces that can be digested and applied more easily by growers.
8. A comprehensive training programme should comprise of the following 5 major subject areas:
   - The Physics of Climate Control
   - Plant Physiology
   - Greenhouse Technology
   - Control Technology
   - Equipment Specific Training & Mentoring
9. Financial assistance may be available from DEFRA through the VTS component of the ERDP. This scheme will provide up to 75% of the cost of providing the training. A full proposal will be required to secure this funding.

4. Action Points for HDC

To move forward the work that has been carried out as part of this project, additional effort is required to:

- Organise courses that can be attended by growers.
- Secure funding from sources such as DEFRA's VTS programme.

HDC are in an ideal position to co-ordinate and direct this activity, particularly as it provides an ideal platform for technology transfer from projects related to energy efficiency and greenhouse climate control.

It is recommended that the key action point for HDC is to facilitate the organisation of a pilot programme of training courses on climate controls. Key features of this pilot programme should be:

- Two, 2-day courses, delivered at a venue in Northern England (Humberside - concentrating on edible crops) and Southern England (West Sussex - concentrating on ornamental crops).
- Syllabus to concentrate on the role of climate control computers in meeting growers current energy saving targets.
- Number of participants on each course will be in the range of 10 to 12.
- For maximum effect in the current energy market climate, it is suggested that this pilot programme should take place early in 2003.
- It is suggested that the course should be delivered by selected UK specialists working in partnership with staff from IPC in Holland.

It is envisaged that this course will attract potential participants who are familiar with modern climate control equipment and who have a desire to keep up with (and apply) the most recent developments. However, as the course is only intended to be a pilot, it is expected that further follow up courses will have content which is designed to meet the needs of specific groups of growers. It is proposed that development of these courses should follow on after the successful completion of the pilot project.

5. Anticipated Practical and Financial Benefits

The major benefit of UK growers making better use of climate control computers is an increase in energy efficiency. Savings in the order of $7^1/_2$% to 10% of heating costs per annum are anticipated. With heating costs for protected crop production currently being in the order of £4.50 to £7.00/m^2/annum, savings of up to £0.50/m^2/annum could be achieved.

Optimal control of the greenhouse climate will also lead to improved crop quality and uniformity thereby improving scheduling, labour efficiency and overall crop management.

A successful bid for funding will reduce the training costs to growers in this key skills area.

Science Section

1 Introduction & Background

An environmental control computer is now an essential tool for the grower of protected crops. Good systems give the user the ability to closely control and monitor the internal conditions within the greenhouse and provide optimum conditions for plant growth. To achieve the desired environment, systems control a wide range of equipment including heating plant (e.g. boilers, CHP & heat stores), fans & ventilators, screens and supplementary lighting.

Commercial designs were first introduced in the late 1970's / early 1980's when temperature sensors were linked to a central microprocessor. This was used to monitor and control the environmental conditions within a greenhouse. Rapid development of the technologies used has seen equipment advance from a simple 'intelligent thermostat' based to a complex system which can now provide the grower with an immensely powerful business management tool. In fact, many modern designs extend beyond the role of mere climate control to include more complex decision support functions.

The rapid development of climate control systems has led to a situation where many growers do not fully utilise the equipment that they have installed in their greenhouses. The physics of greenhouse climate control is a complex subject on its own, so when coupled to the need to understand the operation and set up of a computer based controller, many growers have significant difficulties. As a result many users choose to overlook the problem and trust that the equipment is correctly set-up by the equipment supplier when it is commissioned (following installation) or after regular service & maintenance. The consequence of this approach is that growers do not get the best from the capital investment they have made. By not using the equipment effectively the results may be:

- Sub-optimal crop growth & development leading to poor yield and quality.
- Energy waste.
- Increased operational costs.
- Reduced levels of income.

1.1 Contribution to Improving Energy Efficiency

With the recent increases in the price of energy and the introduction of the Climate Change Levy, many growers are now looking for ways to improve the energy efficiency of crop production. The voluntary agreement between the horticultural industry & government requires growers to achieve a 15% improvement in energy efficiency by 2010. The severity of this target is further highlighted by the fact that the first milestone for the agreement is in October 2002, by which time an improvement of 3% will need to be demonstrated.

The results of research (e.g. Rosenquist, 2000) suggests that using improved control strategies for greenhouse heating and lighting is a cost effective way of achieving significant efficiency improvements. This research suggests that, by using appropriate environmental control strategies, savings of up to 40% can be achieved. An HDC funded study visit to Denmark & Holland (Plackett et al., 2001) identified that, whilst savings of this order may not be achievable in practice, improvements of 10% are quite feasible. Therefore environmental control equipment clearly has an important role to play if the protected horticulture industry is to be successful in achieving the improvements required.

1.2 The Need for Information & Training

As highlighted above, the complex issues surrounding both the operation of climate control computers and the physics of greenhouse climate control is an area where many growers have a significant knowledge gap. This is hardly surprising as many of the concepts and principles are included in courses on environmental control engineering at first-degree level.

The area is further complicated by the fact that the equipment in commercial use in the UK has various capabilities depending upon when it was purchased and installed. The rapid development of technologies over the past few years has led to the situation where equipment that may only be a few years old could be several ‘generations’ behind the current ‘state of the art’. Growers and their key employees therefore need to be able to readily access information and training that will enable them to better understand the capabilities of the equipment available to them. In addition, as R&D (both in the UK and continental Europe) devises new control strategies that improve energy efficiency, growers need to know how to set up their own systems to use the approaches developed.

Much of the current detailed knowledge on greenhouse climate control methods lies in Europe with the major manufacturers (of which there are approximately 6). This is backed with some expertise in the UK agents /subsidiary companies. These commercial equipment

suppliers are driving the development of systems through close liaison with R&D organisations. Much of the available product based training is therefore available from the individual manufacturers who provide their customers with the required tuition. The major focus for this support is in the Netherlands however.

In addition a small number of independent organisations exist that can provide training. One notable example is IPC, who are also located in the Netherlands. This organisation has been used by a small number of the leading UK horticultural companies to provide education programmes specifically tailored to their individual needs.

2 Research

2.1 Objectives

The specific objectives of the project were:

1. To survey growers and determine the current level of knowledge and expertise among UK growers relating to the use of climate control computer equipment.
2. To survey growers and determine what equipment is currently in commercial use in the UK.
3. To survey growers and determine what the education and training needs are for a broad cross section of UK growers.
4. To determine where expertise is available (both in the UK and abroad) that can play a role in a training programme and determine what level of contribution candidate parties can make.
5. To develop the components of a training & education programme which responds to the specific need-s of UK growers.
6. To determine a training delivery strategy that enables growers and their staff to access the information in an efficient manner.
7. To determine how the programme can be cost effective for growers and establish if third party funding may be available to support the programme.

2.2 Method

This project was undertaken by carrying out a programme of work based on:

- Consultations with the protected horticultural sector and key stakeholders.
- Desk based studies to identify and develop the key components of a training package.

Specific details of the methods used are as follows:

2.2.1 Consultation with key stakeholders

Environmental control equipment manufacturers & suppliers, R&D workers, training organisations and providers, crop sector associations, funding bodies and government departments (including DEFRA) were all consulted. Discussions were primarily carried out via telephone. In a number of circumstances face to face meetings were also held. A full list of the organisations and/or individuals consulted is given in appendix one of this report.

2.2.2 Market research

This was carried out through a postal questionnaire to all HDC levy payers with a business interest in protected crops. This questionnaire was used to determine the current status of commercial equipment installations together with collecting information on areas of grower training needs. A copy of the market research questionnaire is attached as appendix two of this report.

2.2.3 Interviews with Growers

Growers were randomly selected to represent a cross section of crop sub-sectors and different business sizes for interview. These interviews were carried out by telephone. A list of the key individuals that were interviewed is also given in appendix one.

2.2.4 Consultation with other industry & commerce sectors

Discussions were carried out with suppliers and organisations in other industrial and commercial sectors that use similar computer controls equipment for either process control or the management of the internal environment within a building. Experiences of similar training and education problems were explored so that an insight into methods that have been effective in other industries was obtained.

This part of the work programme clearly highlighted the unique nature of climate controls in horticulture. Only in this market sector does the manipulation of internal climate have such a marked effect on business performance and, in order to optimise performance, a thorough understanding of crops, the physics of climate control and climate control equipment is required.

In many other sectors, training concentrates on the education of ‘engineers’ in the operation of the climate control equipment. For example it is accepted that the required set points for an office are well known and it is simply a case of setting up a system to meet these requirements. From this point of view it is clear that UK horticulture has little to gain by using the methods employed by other sectors of commerce and industry.

2.2.5 General literature & information review

A desk-based search of relevant information sources was carried out to support the above programme.

3 Discussion – Objectives v Findings

In response to the market research carried out, 205 completed questionnaires were received from growers/ horticultural businesses. These responses covered a protected cropping area of 259ha. This comprised of 461 greenhouses (245ha) and 81 polytunnels (14ha). Of the responses received, 125 businesses had climate control computers. A full summary of the analysis of responses obtained from the questionnaire is given in appendix three.

DEFRA data suggests that there is around 1500ha of protected cropping in the UK. Taken on face value, the responses to the survey therefore only represent just over 16% of the total production area. However in some cases it must be recognised that only 1 response was received from some growers who run 'multi-site' operations. As a result this underestimates the degree of representation received. In addition a good response was received from the 'energy-intensive' sub sectors and, although it is not possible to assess the total area represented, it was felt that the views of a large proportion of the production area were received.

The findings of both the market research and the other consultation / research activities will be fully discussed in the following sections. This will be done by comparing the initial objectives with the findings from the research.

3.1 What is the current level of knowledge and expertise among UK growers relating to the use of environmental control computers?

The results of the consultation showed that expertise on climate control computers is varied and general skill levels are low. As a result the majority of growers responding to the questionnaire identified that they could benefit from further training. Many responses also identified further training to be a high priority.

The current level of expertise has been obtained via three routes.

1. **Information obtained from equipment manufacturers / suppliers.** This is by far the most common way that growers and their staff currently obtain information and training. In total 96 survey responses had received some previous training and 84 of them had been via the equipment manufacturer / supplier. It is clear however that this route is leaving an expertise gap and many users are left dissatisfied with their current level of knowledge & skills. It should be pointed out that criticism should not be levelled directly at manufacturers for this situation. Growers negotiate tight financial deals when purchasing climate control equipment and, as a result, manufacturers and their suppliers operate under tight margins. This therefore gives little scope for the provision of 'added

value' services once the equipment has been installed. The manufacturer can often supply detailed product training, but on the whole growers seem to be reluctant to pay for this additional support.

2. **Detailed training courses.** A number of leading growers have attended and/or arranged for specialist training to be provided by external organisations or consultants (38 of the 96 responses that had received previous training). However use of this approach is not widespread, as growers again seem to be reluctant to pay for training of this type. One major problem with this route is that much of the detailed knowledge lies in the Netherlands. IPC are the major suppliers of this training and their courses tend to be expensive. This is because growers either have to travel to the Netherlands for the courses or, as an alternative, IPC have to send their staff to the UK.
3. **Skills development through general experience.** This appears to be another major route by which growers and their staff acquires expertise. By sharing experience with other growers and general problem solving on the nursery, growers pick up the general principles of environmental control. The major shortfall of this approach is that growers tend to lack in depth background and knowledge of the principles of climate control. As a result they are unable to pre-empt the onset of problems or be pro-active in making improvements.

3.2 What equipment is currently in commercial use in the UK?

A wide range of equipment is currently in use in the UK from all of the major manufacturers. The survey revealed that the current market leaders are Priva who have some 40% of the market. Other strong market brands include VanVliet (now called Hortimax) and Brinkman. Although they currently only have a small number of installations, Hoogendoorn are working hard to increase their market share. TomTech clearly also have a strong market niche, particularly with the smaller protected cropping enterprises.

Data on the age of systems indicates that approximately 50% of the climate control computers have been installed since 1995. This therefore indicates that a significant proportion of systems have the most up to date features and capabilities. It should be noted however that Brinkman have had a reducing UK market share since 1995, and as a result the more recent installations have tended to focus on Priva, VanVliet and TomTech.

3.3 What are the training and education needs of UK growers?

The results of the survey shows that growers perceive their need to be for detailed training that gives recommendations on optimised settings for energy saving and improved crop performance. Whist this may be the culmination of any training, it is clear that any programme needs to provide some detailed background information that will enable this need to be fully addressed. Merely addressing the perceived need will be akin to building a house without first putting down any foundations.

To be competent in the use of climate control, a through understanding of 4 main areas is required. These are:

- **Physics-** a grower needs to have a good understanding of the factors that determine the climate within a greenhouse. This includes light/radiation, temperature, humidity, CO_2, air movement etc. For example, knowledge of the properties of moist air at different temperatures is essential in order that the effects of processes such as heating and ventilation can be fully understood.
- **Crop Physiology –** an understanding of the effect of the greenhouse environment on plant growth and development is essential if production is to be optimised. Two major processes, photosynthesis and transpiration, are key in successful crop development. Both of these can be optimised through good environmental control.
- **Greenhouse Equipment Technology –** an extensive range of equipment is often installed in the modern greenhouse, all of which can impact on the greenhouse environment. These include heating, ventilation, screens, lighting, misting equipment etc. Knowledge of the operation of all of this equipment is a must.
- **Control Technology - t**he modern climate control computer applies the principles of sophisticated control methods. Again an understanding of the background to this technology is essential.

As previously highlighted, this requirement sets horticulture apart from other sectors of commerce and industry and makes the use of the use of training techniques used in other sectors unsuitable. Only by bringing the above four main elements together can the requirement of providing recommendations on settings for individual crops can be satisfied.

It has also been identified that any training must be delivered at a practical level and should include the opportunity for growers to exchange ideas and practical experiences. Without this approach the training will become too intense and the relevance of many of the basic principles will not be appreciated.

3.4 What expertise is available (both in the UK and abroad)?

It is felt that there is currently no expertise available in the UK that could deliver training on all aspects of climate control as an 'off the shelf' package. The only establishment that has been identified which can deliver a complete package is the Dutch organisation IPC.

Having said that, there is a number of UK based individuals and organisations that are well equipped to deliver many of the individual components of an effective training programme. These include some scientists working in R&D establishments, crop consultants, energy/horticultural engineering consultants and equipment manufacturers/suppliers. A full list of candidate organisations and individuals is given as appendix four.

With this in mind it is viable for some of the training to be delivered using UK based expertise, but some co-ordinating resources will be needed to ensure that the correct blend of skills are assembled to deliver the training programme. The potential role of IPC should not be overlooked or underestimated however, and an approach that utilises their expertise clearly makes sense. Ways that IPC may be used include using them to train and update UK based specialists and the use of their staff for delivering specific elements of the programme.

3.5 What are the components of a training programme that will meet the needs of UK growers?

The proposed components of a suitable training programme are as detailed in the following sections. It is proposed that training should be of a modular structure and be based on the broad categories outlined below.

3.5.1 The Physics of Climate Control.

- The inter relationships between air temperature, moisture content, plant temperature etc.
- Understanding and using a Psychometric chart.
- Climate control processes including heating, ventilation, air mixing etc.
- Measurement of radiation, light units, solar radiation, visible radiation etc.
- The energy balance of the greenhouse.

3.5.2 Plant Physiology

- The processes of plant growth including photosynthesis, respiration, and plant development including transpiration, vegetative/generative balance etc.

- The influences of climate on plant growth including humidity, moisture deficit, light, temperature, CO_2 and air movement.
- Temperature integration.

3.5.3 Greenhouse Technology

- The climate control computer – hardware & software, sensors & measuring equipment.
- Heating systems – Pipe systems v Air systems, boilers, pumps, mixing valves etc.
- Ventilation systems – ventilation design, the use of fans etc.
- Screens
- CO_2 – methods of enrichment, flue gases v pure sources, the use of buffer tanks etc.

3.5.4 Control Technology

- The control loop, characteristics of control strategies, equipment control methods etc.
- Example control programs including basic settings for temperature control (including boiler control), humidity control, screen control, CO_2 and supplementary lighting. The use of influences on radiation, humidity etc also to be included.
- Using and interpreting graphs.
- Heating management and energy management including the use of minimum pipe temperature, ventilation management etc.

3.5.5 Equipment Specific Training and Mentoring.

- Getting the best from a particular system, including the use of make/model specific features
- Sharing experiences with other users and/or system specialists.

3.6 What delivery strategy will enable growers (and their staff) to access the training in an efficient way?

As previously highlighted it is recommended that the training:

1. Must be delivered at a practical level and should include the opportunity for growers to exchange ideas and practical experiences. Without this approach the training will become too intense and relevance of many of the basic principles will not be appreciated.

2. A modular approach should be used. This will enable information to be delivered in bite-sized chunks that can be taken on board before moving on to other issues. This is seen to be a key advantage of using UK based resources rather than relying solely on European based organisations such as IPC. If expertise is brought over from Europe it is likely that courses will be intensively delivered over a short period of time. This intensive 'classroom' approach is not necessarily the best method of delivering information to people that are used to working in a practical environment.

In addition it is recommended that courses be delivered to a sector specific audience wherever possible. This is because the needs of a grower of edible crops are very different to those of a cut flower grower for example. Having said that, it would be possible to deliver the preliminary modules as common elements, thus further re-enforcing the validity of this approach.

As part of the training materials, supporting notes should be prepared. In the long term these will act as a reference source on the subject matter covered in the training. It should be noted that IPC already produce an excellent book that covers much of the subject matter that needs to be included. Entitled 'Computerised Environmental Control in Greenhouses' (Kamp & Timmerman, 2002) this publication may even be used as the key reference resource for the training programme.

Consideration should be given to using newer methods of information delivery including the Internet and email. Many growers now have these facilities and therefore it may be possible to deliver course background materials in a modular form using this approach. For instance, follow up exercises and worked examples could be delivered to participants by email, with reference notes being available via the HDC web-site (in Adobe acrobat format for example).

3.7 Is third party funding available that will enable growers to support a training programme on environmental controls?

Yes, funding could be available from a number of sources including DEFRA and the Department for Education & Skills. In addition some limited support could be available through the Carbon Trust's Action Energy programme.

Many of the funding sources have limitations in the amount of financial support available or are based on the availability of loans at reduced or zero rates of interest. With this in mind the most promising source of support would appear to be the Vocational Training

Scheme (VTS) of the England Rural Development Programme (ERDP). This DEFRA scheme will provide up to 75% funding for training in a wide range of skills and disciplines.

Because of the nature of training in climate control computers and the efficiency improvements that will result from better equipment use, the type of training being considered here fits the funding criteria well.

ERDP normally allocate VTS funding on a regional basis, so bids based on this approach are simplest from an administrative point of view. However national courses are not out of the question, but information on how many people will be trained from each of the individual DEFRA defined regions will have to be submitted in any funding proposal.

4 Conclusions

1. Current skill levels relating to the use of climate computers are varied.
2. Many growers recognise further training as a high priority issue.
3. Skills are available both in the UK and Europe to deliver detailed training packages. An ‘off the shelf’ package is not immediately available in the UK and some co-ordinating resources would be needed to assemble the necessary skills. On the other hand IPC (based in the Netherlands) could deliver packages with immediate effect that may be tailored to the individual needs of specific growers / industry sub-sectors.
4. It is recommended that training should be delivered on a modular basis. This enables material to be conveyed in ‘bite-sized’ pieces that can be digested and applied more easily by growers. This approach favours delivery by UK based specialists backed by the skills of organisations such as IPC.
5. A comprehensive training programme should comprise of the following 5 major subject areas:
   - The Physics of Climate Control
   - Plant Physiology
   - Greenhouse Technology
   - Control Technology
   - Equipment Specific Training & Mentoring
6. Financial assistance may be available from DEFRA through the VTS component of the ERDP. This scheme will provide up to 75% of the cost of providing the training. A full proposal will be required to secure this funding.

5 Recommendations for Future Work

To further develop the programme, and secure funding from sources such as DEFRA's ERDP VTS scheme, more detailed planning and co-ordinating resources are required. A successful bid under this scheme will require specific details including a business plan and cost / benefit analysis to be submitted.

The work carried out under this study provides all of the background information required to submit a bid for funding under this scheme. It is therefore recommended that to move the initiative forward without embarking on the development of a complete programme, a 'pilot' programme should be pursued. This approach has the advantage that a progressive approach to course development and resource allocation can be taken.

It is proposed that this programme should concentrate on the facilitation of two, 2-day training courses that will concentrate on the role of climate control computers in meeting growers current energy saving targets. It is proposed that these courses will be delivered at a venue in Northern England (Humberside - concentrating on edible crops) and Southern England (West Sussex - concentrating on ornamental crops).

A proposed course syllabus is as follows:

Day 1.

- The need for energy saving. Energy targets & Climate Change Levy (CCL).
- Plant physiology and interaction with the greenhouse environment.
- The influence of light, humidity, CO_2 and air movement.
- Humidity control in the greenhouse – the relationship of humidity to air and plant temperature
- The principle of temperature integration.
- Reading and interpreting graphs.

Day 2.

- Energy management and the role of climate controls.
- Using temperature integration in practice.
- Creating improved climate control strategies.
- Putting theory into practice – how to save money on your nursery.

It is suggested that the course should be delivered by selected UK specialists working in partnership with staff from IPC in Holland. The number of participants on each course will be in the range of 10 to 12. For maximum effect in the current energy market climate it is suggested that this pilot programme should take place early in 2003.

It is envisaged that this proposal will attract potential participants who are familiar with modern climate control equipment and who have a desire to keep up with (and apply) the most recent developments. However, as the course is only intended to be a pilot, it is expected that further follow up courses will have content which is designed to meet the needs of specific groups of growers. It is proposed that development of these courses should follow on after the successful completion of the pilot project.

References

Kamp, P.G.H. & Timmerman, G.J. (2002) Computerised Environmental Control in Greenhouses – a step by step approach. Second edition ISBN 90-75627-01-7.

Plackett, C.W., Clarke, I, Holmes, M & Hicks, P.J. (2001), the use of dynamic control systems for the production of high value ornamental crops in the UK – A technical assessment. HDC Project Report PC172.

Rosenquist, E & Aaslyng, J.M. (2000), IntelliGrow – a new climate control concept. *Gron Vinden Horticulture* No 122.

Appendix One – List of key organisations & individuals consulted during this study.

A large number of organisations and individuals were contacted and consulted during the course of carrying out the work described in this report. The following list gives details of the most useful contacts.

Government Departments / Funding Bodies etc		
DEFRA	Matthew Hampshire Sue Warner Jon Fewings	020 7238 6000 01270 754000 0118 939 2057
Department for Education & Skills	via Website	www.dfes.gov.uk
NFU	Jonathan Pettit	020 7331 7408
Lantra	Madge Moore	024 7669 6996
The Carbon Trust	Dr Andy Lewry	andy.lewry@thecarbontrust.co.uk
Action Energy	Nick Hewitt	01923 664642
Education Organisations		
Reading University	Prof. Chris Payne	c.c.payne@reading.ac.uk
IPC	Ben van den Brink Lucas Gerrits	0031 318 697111 0031 318 697111
Controls Equipment Suppliers & Manufacturers		
Priva	Chris Addis	01684 855809 chris.addis@priva.co.uk
Hortimax (formerly Van Vliet)	Victor Lambert	01482 668676
Hoogendoorn	Mark Chivers	01243 586743 mc@hoogendoorn.nl
Tom Tech	Alan Thompson Sue Thompson	01945 700553 mail@tomtech.co.uk
LVZ Automation	Leon Van Zijl	01243 860700
Ecotech (UK) Ltd	Ross Hibbs	01430 449446

Growers		
W.J.Findon	Andrew Fuller	01789 292792 andrewf@wjfindon.co.uk
SGP	Dave Abbott	01243 554026
Humber VHB	Dave Palmer	029 2079 5867
Double H	Steve Rickman	01590 682749
Crystal Heart	James Bean	01430 432200
Swedeponic	Patrick Bastow	01778 424224
C & A Benson Ltd	Clive Benson	01775 723501
R.F.Geater & Sons	Ron Geater	01728 830616
Bridge Farm Nurseries	Tony Ball	01775 767194
Commercial / Industrial controls manufacturers & suppliers		
Trend Controls Ltd	via Website & email	www.trend-controls.com
Invensys Climate Controls Europe	via Website & email	www.satchwell.co.uk

Appendix Two - Climate Control Computer Systems Survey Form

This HDC survey is voluntary and has been designed to identify the range of environmental equipment in use in protected horticulture in the UK and ascertain the specific training needs of growers and their staff in this area. The overall aim is to improve the efficiency of energy use, helping growers to reduce costs and comply with legislation.

This information will be treated confidentially by HDC and its contractor, Farm Energy Centre, who will only publish summaries of the data collected. Details from the survey will not be passed on to environmental control equipment manufacturers. The summarised results of the survey will be available to HDC members in the final report for HDC project PC 183 in early summer.

~~1~~*Grower Site*

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Name	
Position in Company	
Business Name	
Nursery Name	
Address	
Post Code	
Telephone	
Fax	
email	

~~2~~*Crop Details*

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What are the main crops you grow in your business?

- ☐ Tomato
- ☐ Cucumber
- ☐ Pepper
- ☐ Lettuce
- ☐ Other Protected Edible Crops
- ☐ Other. (Please state)
- ☐ Young Plants
- ☐ Cut Flowers
- ☐ Hardy Nursery Stock
- ☐ Bedding Plants
- ☐ Pot Plants

_____

~~3~~*Greenhouse/s & heating system details.*

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Please give details about your greenhouse/s and their heating systems in the following table.

Greenhouse Type (Glass / Polytunnel)	Area (m^2)	Approx. Year of Construction	Typical Heating Temperature (°C)	Length of Heating Period (no. of months per year / AYR)	Heating system type			
					Hot Water	Steam	Hot Air	Other (please state)

If you have insufficient space above to enter details for all of your greenhouses, please photocopy this page and continue on an additional sheet.

4Environmental Control Computer Details

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Do you have a climate control computer installed in your greenhouse/s?

Yes – in all	Yes – in some	No

If you answered *no*, please proceed to Section 7.

If you answered *yes*, please continue and provide the following information.

Who is the manufacturer of the control computer(s)?

Manufacturer / Make	Please tick all that apply	Year of Installation	Purchased new or second-hand
Brinkman			
DGT			
Hoogendoorn			
Priva			
Van Vliet			
Tom Tech			
Other (please state)			

Who in your business are the main users of the climate control computer?

	Please Tick
Business Owner	
Nursery Manager	
Crop Manager	
Technical Manager	
Crop Consultant	
Other (please state)	

Who is responsible for the following?

	Business Owner	Nursery Manager	Crop Manager	Technical Manager	Crop Consultant	Other (please state)
Input of settings.						
Maintenance & regular updates.						
Regular monitoring / reporting.						

~~5~~*Previous training*

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Have you and/or your staff had any previous training in the use of the climate control computers?	Yes	No

If yes, which of the following best describes the training received?

Basic training from the equipment installer / manufacturer	
Detailed information from the equipment installer / manufacturer	
Detailed training from third party trainer i.e. consultant, researcher etc.	

Future Training Needs

Do you think that your business could benefit from a better understanding of the use of environmental control computers?	Yes	No

If yes, how highly do you prioritise further training?

Very high	High	Medium	Low

Which of the following best describes the type of training that you think would be most appropriate to your needs?

Background information - the fundamentals of greenhouse environmental control and the use of climate computers.	
Selecting settings – how to better use computer controls to optimise crop performance and energy savings.	
Detailed training – a complete course on how to get more from the particular system you use – i.e. capabilities, how to change settings, produce reports, day to day operation etc.	
Membership of a 'Climate Computer Users Club' – a forum for growers to exchange information & experiences on practical use of climate controls.	

Who in your business do you feel would benefit most from this training?

Business Owner	Nursery Manager	Crop Manager	Technical Manager	Crop Consultant	Other (please state)

~~7~~*Completion and return.*

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Please add any further comments that you consider relevant to this work

_____

_____

_____

Please check that you have completed all relevant sections and return to HDC in the pre-paid envelope by Friday 22 February 02 in the pre-paid envelope provided. Thank you for your help.

Appendix Three: HDC PC 183 Climate Control Computer Systems Questionnaire Results Summary

Level of response

A total of 850 questionnaires were sent to HDC members (with an interest in protected crops) of whom 205 returned completed forms.

General greenhouse data

Information on the area and type of greenhouse was collected as follows:

Greenhouse Type	Total Area (Ha)	Number of Greenhouses
Glass	245	461
Polytunnel	14	81
Totals	259	542

Greenhouse Age

Construction Date	Area (Ha)	
	Glass	Polytunnel
Pre 1971	27	2
1971-1980	54	1
1981-1990	74	3.3
1991-2000	86	5.5
2001-Current date	4	2.2

Heating System Type

Type of System	Area (Ha)
Hot Water	172
Steam	18
Hot Air	62
Other (e.g. Radiant etc.)	2

The Use of Climate Control Computers.

Responses with climate control computers installed in their greenhouse/s.

Yes – in all	94
Yes – in some	34
No	80

Information on the use of computers within the main protected crops is as follows:

Crop	No of Responses	No. Using Climate Computers	
		In All Production Areas	In Some Production Areas
Tomato	34	27	2
Cucumber	18	17	-
Lettuce	16	10	2
Pepper	8	5	1
Other Protected Edible Crop	18	9	1
Young Plants	31	13	10
Cut Flowers	30	14	6
Hardy Nursery Stock	40	5	11
Bedding Plants	74	21	15
Pot Plants	59	27	14

Environmental Control Computer Details

Manufacturer Details

Information obtained on the manufacturer of the climate control computers was:

Manufacturer	Number of Installations	Installed New	Installed 2nd Hand
Brinkman	17	14	3
DGT	2	2	-
Hoogendoorn	4	4	-
Priva	47	47	-
Van Vliet	28	27	1
Tom Tech	24	21	3
Other	6	5	1

Age of Systems

Manufacturer	Age of System			
	Pre 1990	1991-1995	1996-2000	2001 on
Brinkman	8	5	2	1
DGT	-	1	1	-
Hoogendoorn	-	-	3	1
Priva	9	18	18	2
Van Vliet	6	6	12	2
Tom Tech	-	5	12	3
Other	2	2	2	-

Please note totals in this table may not agree with data given in section 4.1. This is because not all responses included full information on the age of systems

Who in your business uses the climate control computer?

Main users of the climate control computers are:

Business Owner	97
Nursery Manager	59
Crop Manager	33
Technical Manager	16
Crop Consultant	5
Other (please state)	2

In both cases the 'other' was use by nursery maintenance staff.

Who is responsible for the following?

	Business Owner	Nursery Manager	Crop Manager	Technical Manager	Crop Consultant	Other
Input of settings.	60	36	19	7	3	-
Maintenance.	54	23	10	6	-	10 (Manufacturer/ Supplier)
Regular monitoring / reporting.	72	40	33	11	2	5

Previous training

Numbers of growers / nursery staff that have previously had training are:

Yes	No
96	103

Type of training previously received was:

Basic training from the equipment installer / manufacturer	84
Detailed information from installer / manufacturer	38
Detailed training from third party trainer i.e. consultant, researcher etc.	38

Future Training Needs

108 responses said they thought they could benefit from further detailed training on the use of climate control computers.

This training was prioritised as follows:

Very high	High	Medium	Low
19	42	31	9

The type of training that was considered to be most appropriate was scored as follows?

Background information on the fundamentals of greenhouse environmental control and the use of climate computers.	23
Typical settings for optimising crop performance and energy savings.	77
Detailed training on how to get more from your on the particular system you use – i.e. capabilities, how to change settings, produce reports, day to day operation etc.	41
Membership of a 'users club'	32

Those who could benefit most from training was scored as follows.

Business Owner	Nursery Manager	Crop Manager	Technical Manager	Crop Consultant	Other
71	51	35	12	4	8

Appendix Four – Candidate organisations / personnel who may be involved in the delivery of training.

The following is a list of candidate organisations / individuals that may be involved in the delivery of a training programme on greenhouse climate control / climate control computers. Whilst every effort has been made to ensure that this list is as comprehensive as possible, no liability is accepted for errors or omissions.

Organisation	**Name/s**	**Key Modules where expertise may be used.**
FEC Services	Chris Plackett	One, Three & Four
	Tim Pratt	One, Three & Four
	Andrew Kneeshaw	One, Three & Four
Hennock Industries	Andrew Marchant	One, Three & Four
Greenmark International	Peter Stearne	One, Three & Four
National Energy Foundation	Gareth Ellis	Three
HRI	Ian Clarke	Two & Four
	Jo Basham	Two & Four
	Steve Adams	Two & Four
	Ken Cockshull	Two
	Allen Langton	Two
Grodan	Andrew Lee	Two & Four
Independent Consultants	Derek Hargreaves	Two & Four
	Gerry Hayman	Two & Four
	Alan Wright	Two & Four
Priva UK Ltd	Nick Field	Four & Five
Hoogendoorn Automation	Rene Beerkens	Four & Five
	Ted van den Akker	Four & Five
Tom Tech	Peter Thompson	Four & Five